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Performance Assurance Requirements

for the

Space Environment Monitor

SEM

Specification SEL 86-2

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SPACE ENVIRONMENT LABORATORY
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
325 Broadway
Boulder, Colorado 80303

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for the Space Environment Monitor

Specification SEL 86-2

Approved:

David S. Evans	2/9/87 date
William P. Barrett	9 Feb 87 date
Herbert H. Sauer	9 Feb 87 date
Lorne D. Matheson	Feb 1987 date
Robert H. Bushnell	1987 Feb 9 date

Technical Advisory Committee
to the
Source Selection Advisory Committee
for the
Space Environment Monitor

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PERFORMANCE ASSURANCE REQUIREMENTS FOR THE SPACE ENVIRONMENT MONITOR SEM

1. GENERAL REQUIREMENTS

1.1 BASIS AND SCOPE OF THE REQUIREMENTS

This document incorporates the applicable portions of the National Aeronautics and Space Administration (NASA) Reliability and Quality Assurance Handbooks NHB 5300.4(1A) and (1B) and, in addition, contains other elements of performance assurance such as reviews, functional and environmental testing, and contamination control.

1.2 GENERAL REQUIREMENTS

The contractor shall establish and maintain an organized performance assurance program, that encompasses flight and flight-support equipment, government-furnished property, and spares, for demonstrating that the design meets the functional requirements, including specified margins, that the hardware has been manufactured properly and will operate properly in association with all other spacecraft components, and that the software meets design and mission requirements. The program applies to all work accomplished by the contractor and his subcontractors and suppliers (also termed "contractor") who provide software, flight hardware, and support.

1.3 PERFORMANCE ASSURANCE PLAN

The contractor shall prepare a Performance Assurance Plan and submit it in accordance with Appendix A. The Performance Assurance Plan shall describe the contractor's system for accomplishing the assurance activities in compliance with the requirements herein. The approved Plan and this document shall become part of the contract negotiated between the contractor and SEL. If any inconsistencies between the approved Performance Assurance Plan and this document become evident, this document shall take precedence, except where specific deviations were identified and approved before award of the contract.

The contractor is encouraged to make maximum use of his existing practices and procedures in complying with this document. Applicable practices and procedures shall be submitted with the Performance Assurance Plan.

1.3.1 Preparation of the Performance Assurance Plan

The Performance Assurance Plan shall address each of the nine sections of this document and shall describe specifically and in detail how the requirements are to be accomplished. In addition, the Plan shall include:

a. An organization chart and defined responsibilities.

b. A matrix of the requirements, referencing the applicable section numbers in the Plan versus the procedures, instructions, and specifications.

c. A list of assurance services that may be procured, identifying the proposed subcontractor.

d. Copies of procedures and instructions referenced in the Plan. Revisions to these documents shall be submitted in accordance with Appendix A.

e. Identification of significant hardware items to be purchased, categorization of these for assurance purposes, and a detailed description of the portions of this document to be imposed on each cateory.

1.4 USE OF PREVIOUSLY DESIGNED, FABRICATED, OR FLOWN HARDWARE

The contractor shall demonstrate that the proposed hardware will comply with the requirements of this document as well as the Technical Specification.

When previously designed, fabricated, or flown hardware is proposed for use on this project and is considered to have demonstrated compliance with the requirements of this document, the contractor shall submit substantiating documents. The documents shall:

a. Compare each performance, design, and interface requirement for this procurement (as delineated in other documents related to this procurement) with the corresponding previous requirement. For any that do not comply, either describe what modification will be made to achieve compliance or provide a rationale and supporting information stating why the deviation is considered acceptable.

b. Compare each performance assurance requirement for this project (as delineated in this document) with the corresponding previous requirement. For any that do not comply, describe what will be done to achieve compliance or provide a rationale and supporting information stating why the deviation is considered acceptable. In addition, state how any modifications proposed as a result of section 1.4a will be shown to comply with the performance assurance requirements of this document.

c. Compare the manufacturing information for the hardware proposed for this procurement with that for the previous hardware. As a minimum, this comparison shall include the name and location of the manufacturer, the date of manufacture, any design changes, any changes to parts or materials, any modification to packaging techniques, and any change to fabrication or assembly processes.

d. Describe all flight experience with the proposed hardware including, in particular, a description of all failures or anomalies, their causes, and any corrective actions that were taken as a result.

Such documentation shall be submitted to SEL with the proposal and shall be updated in accordance with Appendix A.

1.5 MANAGEMENT OF THE ASSURANCE PROGRAM

The contractor shall implement a system for effective management control and audit of the assurance program. He shall assign responsibility and authority for managing the assurance activities to individuals who have unimpeded access to higher management.

1.6 PERFORMANCE ASSURANCE STATUS REPORT

Each month a Performance Assurance Status Report shall be prepared that contains the status of the assurance activities, any deficiencies that could affect the hardware, and the intended corrective action. The report shall cover the following appropriate items, as well as those called for in the individual sections of this document:

a. Significant assurance problems
b. Key organization and personnel changes
c. Unresolved hazards (safety program)
d. Significant inspection and test activities
e. Status of procurements and subcontractor performance

The Performance Assurance Status Report shall be submitted to SEL in accordance with Appendix A. It may be submitted as part of the contractor's technical report.

1.7 SURVEILLANCE OF THE CONTRACTOR

The work, activities, and operations of the contractor, subcontractors, and suppliers shall be subject to evaluation, review, survey, and inspection by government-designated representatives from SEL, the GSFC Project Office, the Government Inspection Agency (GIA), or an independent assurance contractor (IAC). SEL will delegate comprehensive and specific in-plant responsibilities and authority to these agencies in a letter of delegation or in the SEL contract with the IAC.

The contractor shall provide the government representative with documents (including an approved Performance Assurance Plan), records, equipment, and working areas within his facilities that the government representative requires for performing his overview activities.

Where contractor source inspection is used, the contractor shall provide a list of duties, responsibilities, and authorities of his at-source quality assurance (QA) personnel to the designated Government quality representative at the contractor's facility. When both contractor and Government source inspection personnel are used at any supplier's facility, the listing shall also be provided to the Government source representative at that facility, upon issuance of the procurement.

1.8 GENERAL PROCUREMENT REQUIREMENTS

The contractor is responsible for ensuring that all contractor purchased products and services meet the requirements of this Performance Assurance Requirement.

1.8.1 Selection of Sources

When the contractor selects procurement sources, he shall assign assurance personnel to participate in the selection. Performance history, receiving inspection and test results, supplier rating system, and survey results shall be used to assess the capability of each potential procurement source in producing reliable products.

1.8.2 Requirements on Subcontractors and Suppliers

The contractor shall ensure that his procurement documents impose the applicable requirements of this document on subcontractors and other suppliers. The subcontractor and other suppliers shall in turn impose the requirements on their procurement sources.

1.9 AUDITS

The contractor shall conduct audits of his assurance activities and those of his subcontractors and suppliers to ensure compliance with appropriate provisions of this document, the Performance Assurance Plan, and the provisions of the contract. To verify the effectiveness of the assurance systems, each audit shall include an examination of operations and documents, as well as an examination of articles and materials. The audit program shall be defined in the Performance Assurance Plan.

1.9.1 Subcontractor and Supplier Audits

The contractor shall perform audits of his subcontractors and suppliers as necessary to ensure compliance with the subcontractor performance assurance requirements. The contractor's schedule and conduct of the audits shall be based on the following:

a. Criticality of items being procured, those items identified by failure mode, effects, and criticality analyses, or information from trend analyses

b. Known problems or difficulties

c. Supplier quality history

d. Remaining period of supplier performance

The audit program for the subcontractors and suppliers shall be defined in the Performance Assurance Plan.

1.9.2 Audit Reports

A documented account of audits shall be submitted to contractor management with recommendations for correcting any deficiencies. Management shall take action to ensure correction of any deficiencies and shall conduct reviews to ensure that the corrections have been made.

Audit reports shall be made available to the government representative on request, and a summary of the audit reports shall be submitted to SEL as part of the Performance Assurance Status Report (section 1.6).

1.10 APPLICABLE DOCUMENTS

To the extent referenced herein, applicable portions of the documents and revision levels listed in Appendix B form a part of this document.

1.11 GLOSSARY

Appendix C lists definitions which are significant for understanding and use of this PAR.

1.12 DELIVERABLE DATA AND SEL RESPONSE

Appendix A lists the deliverable data and cites when the data shall be delivered and whether it is required for SEL approval, review, or information.

2. REVIEW

2.1 GENERAL REQUIREMENTS

The contractor shall conduct a review program of planned, scheduled, and documented reviews covering the flight hardware, flight software, flight- and ground-support equipment, software, operations ground equipment, and ground data processing for which the contractor has responsibility. The contractor's program shall include internal reviews at the component and instrument levels as required by section 2.5, and support to reviews conducted by SEL. These reviews of the contractor's work shall take place at specified times during the course of the program and shall serve the purpose of both contractor technical management and government assessment.

System safety shall be an agenda item for each review in the program.

2.2 ASSURANCE REVIEWS

The contractor shall support a series of comprehensive assurance reviews that are conducted by SEL. For each review, the contractor shall:

a. Develop and organize material for oral presentation to the review team. Copies of visual aids and other supporting material that are pertinent to the review shall be submitted in accordance with Appendix A.

b. Give a complete presentation on, but not be limited to, the status of design, production and test.

c. Support splinter review meetings that result from the major review.

d. Produce written responses to recommendations and action items that result from the review.

Each assurance review shall be held at the contractor's plant. Conference space, sufficient to accommodate the SEM contractor's representatives and up to twenty (20) Government and spacecraft contractor personnel, shall be furnished by the SEM contractor. The SEM contractor shall give the Contracting Officer at least thirty (30) days advance notice of each review date.

2.3 ASSURANCE REVIEW PROGRAM

The Assurance Review Program shall consist of reviews of the individual instruments and Models and associated systems as follows:

a. System Concept Review -- A System Concept Review (SCR) shall be conducted 4 months after the contract is awarded. The SCR shall emphasize the instrument design approach, with data analyses, to satisfy the Technical Specification, as well as plans to verify meeting the Technical Specification.

b. Preliminary Design Review -- A Preliminary Design Review (PDR) shall be conducted at the conclusion of the detailed design efforts and after testing the breadboard models of critical designs. Topics to be reviewed shall include designs, analyses, calibration techniques, and test plans. Long leadtime procurements can be initiated after the PDR. For procurements prior to the PDR, SEL approval is required.

c. Critical Design Review -- A Critical Design Review (CDR) shall be conducted at the conclusion of the design, fabrication, and testing of the Engineering Model. Topics to be reviewed shall include design, analyses, calibration, testing, and part activities. Plans for testing the protoflight and flight units will also be discussed. Attention shall be given to problems.

d. Pre-Environmental Review -- A Pre-Environmental Review (PER) shall be conducted before the environmental test of each instrument to ensure that the instrument is ready for environmental testing.

e. Pre-Shipment Review -- A Pre-Shipment Review (PSR) shall be conducted at the conclusion of the instrument environmental, calibration, and acceptance testing and before delivery. Items to be considered as a minimum in this review are acceptance test results, environmental test results, and malfunction reports. Delivery of the protoflight and flight units to the spacecraft contractor's facility shall not take place until after the resolution of all action items resulting from the respective PSR's unless otherwise directed in writing by SEL.

2.4 INTERFACE MEETINGS

The SEM contractor shall participate in spacecraft interface meetings at the spacecraft contractor's plant (RCA). The SEM contractor shall provide one person to attend each of these meetings (six anticipated) for a period of two days for each meeting. They will occur approximately every 4 months after SCR.

2.5 INTERNAL REVIEWS

The contractor shall conduct a program of internal reviews at both instrument and component levels. The program shall consist of a PDR and a CDR at each box level and at lower levels of assembly when required.

Packaging reviews shall be conducted on all electrical, electronic, and electromechanical (EEE) components in the flight system. Each packaging review shall evaluate the ability of the packaging concept and design to perform successfully during testing and under operating and environmental conditions of the mission. These reviews shall be conducted in accordance with GSFC S-311-98A, "Guidelines for Conducting a Packaging Review" (see Appendix B). In addition to these packaging guidelines, the packaging reviews shall specifically address the following:

a. Placement, mounting, and interconnection of each EEE part or circuit board or substrate

b. Structural support and thermal accommodation of the boards and substrates and their interconnections in the component design

c. Provisions for protection of parts and ease of inspection.

Component level CDR's and PDR's shall include reports of pertinent part stress analyses required by section 7.3.2 and reports of the corresponding component packaging reviews including the results of associated tests and analyses.

Contractor personnel who are not directly responsible for hardware design shall conduct these internal reviews. The government reserves the right to attend the reviews and require notification to SEL 15 working days before each review. The results of the reviews shall be documented, and a summary of each review shall be included in the Performance Assurance Status Report (section 1.6). On request, the review data shall be made available to SEL.

3. PERFORMANCE VERIFICATION, TEST AND CALIBRATION

3.1 GENERAL REQUIREMENTS

a. A Performance Verification Program shall be conducted to ensure that the instrument meets the Technical Specification and the Performance Assurance Requirements. The program consists of a series of: 1. analytical investigations, 2. physical property measurements, 3. functional tests and 4. environmental tests that simulate the environments encountered during transportation, prelaunch, launch, and in-orbit flight.

b. The Performance Verification Program shall demonstrate supporting components and equipment, such as flight software and ground-test hardware and software and show that they meet the Technical Specification. It may also demonstrate interfaces to networks and control centers. Verification of these items may be included in a single Performance Verification Program.

c. All Engineering Model and protoflight hardware shall undergo qualification. All other flight hardware shall undergo acceptance.

d. Environmental specifications for this instrument are contained in Appendix D.

e. A goal is that the non-destructive tests show the actual margin of performance beyond compliance, not just compliance. This particularly applies to EMI.

f. The tests and calibrations specified in this PAR are intended to give a minimum verification of performance. The SEM contractor may define additional tests appropriate to the particular design and needs of the program. Functional tests begin with assemblies.

g. Successful completion of the test effort by the SEM contractor shall not of itself require acceptance of the equipment by the Government.

h. Test Manager -- A qualified individual shall be assigned to manage the test and calibration. This Test Manager shall be responsible for preparation of test and calibration plans, proper peformance of tests and calibrations, interpretation of the data, maintenance of the test and calibration files, preparation of record books, review of calibration computer programming, and review of radiation stimulus equipment designs. The Test Manager shall review SEM and GSE designs to assure that they permit the required test and calibration. The Test Manager shall serve as a focal point with the COTR to ensure that the calibrations are satisfactory to the Government operational and scientific staff and that the information necessary to process and interpret the spacecraft test and in-flight data is obtained.

3.2 DOCUMENT REQUIREMENTS

The management approach for accomplishing the Performance Verification Program shall be described in the Performance Assurance Plan (section 1.3). In addition, the following specifications, plans, procedures, and reports are required to define the technical aspects of the Performance Verfication Program.

3.2.1 Verification Plan

a. The contractor shall prepare a Verification Plan for test and calibration that specifies the technical approach to accomplish the Performance Verification Program. It shall describe the flow of the specific tests and analyses for demonstrating that hardware complies with the performance verification requirements contained in sections 3.3 through 3.6. In defining

quantitative environments under which the hardware elements must meet the Technical Specification, the Verification Plan shall consider instrument interactions with the spacecraft.

b. Tests and calibrations shall be sufficient to assure compliance with the Technical Specification and the Performance Assurance Requirements and to obtain all information needed for full interpretation of the in-flight data.

c. For each test conducted at the component and instrument levels, Verification Procedures shall be prepared that describe how each test contained in the Verification Plan will be done. The procedures shall describe details such as objectives, test phases and profiles, configuration of the item, instrumentation, facilities, operation, test article functions, test parameters, quality control checkpoints, data collection, safety considerations, contamination control, personnel responsibilities, and reports. It shall also include a rationale for retest determination that does not invalidate previous verifications. When appropriate, the interaction of the test and analysis shall be described.

d. For each analysis, the plan shall include objectives, a description of the mathematics, assumptions on which the analysis will be based, required output, criteria for assessing the results, the interaction with related tests, if any, and reports.

e. The Verification Plan shall be delivered to SEL in accordance with Appendix A. Test and calibration plans and procedures shall be submitted for the COTR's review and approval at least forty five (45) days prior to initiation of each planned effort.

3.2.2 Unscheduled Activities

To avoid unscheduled activities during verification an operational procedure shall be established for controlling, documenting, and approving all activities that are not part of an approved procedure. The contractor shall be alert to the hazard potential of last-minute changes and shall institute controls at appropriate management levels for preventing accident or injury or hardware damage. Such control shall include appropriate realtime decision making mechanisms to expedite continuation (or suspension) of testing after malfunction, with documented rationale. The control procedure shall be contained in the Performance Assurance Plan (section 1.3) and shall be referenced in each Verification Procedure.

3.2.3 Verification Reports

After completion of each component and instrument verification, the results shall be submitted in a report in accordance with Appendix A. For each test, the report shall contain, as a minimum, the information described in the sample test report (see attachment) and other information specifically requested in this document. For each analysis, the report shall describe the degree to which the objectives were met, how well the test data validated the mathematical model, and other significant results. In addition, as-run verification procedures, as well as all test and analysis data, shall be made available for review at the contractor's facility on request.

3.2.4 Test Record and Calibration Book

A record of all tests which could aid in interpretation of the in-flight data and all calibrations made for each instrument shall be organized and maintained in a test and calibration record book(s) for each Model (ref. TS 3.4). A summary section for each record book shall be prepared and shall contain functional equations and charts depicting the final calibrations of each Model and each TED and MEPED output as determined from all tests performed prior to delivery of the Model to the Government.

3.3 FUNCTION TEST

3.3.1 Breadboard and Component Tests

3.3.1.1 Sensor Tests, Nuclear Tests and Calibrations

a. The complete Engineering Model Sensor assemblies shall be tested. The tests shall include, but not be limited to, energy thresholds, efficiency, geometric factor, and spurious responses. The test may utilize the SEM electronics, or suitable electronic systems, to demonstrate compliance of the sensors with the Technical Specification and to calibrate the SEM. The tests shall use actual, representative nuclear sources, such as particle accelerators. As the use of the required experimental facilities is expensive and because the range of particle types and energies is somewhat restricted, the nuclear tests are not required to be exhaustive. Maximum use should be made of a sound theoretical understanding of sensor operation to extrapolate from a limited set of measurements.

b. Laboratory calibrations using particle accelerators supplemented by representative nuclear sources shall be performed on each TED. For the MEPED such tests shall be performed on the EM and PM only.

c. Reasonable facilities shall be accorded to the Government to witness nuclear tests and calibrations and to interact with the Test and Calibration Manager to ensure that sufficient data are obtained.

d. If model tests or in-flight data suggest the need for additional calibrations or diagnostic tests, the SEM contractor shall support the operation of the SEM at a calibration facility designated by the Government. The test plan will be agreed upon beforehand by the COTR and the SEM contractor.

e. All sensor assembly test results shall be reported.

3.3.1.2 Tests on Breadboard Models

a. Before beginning assembly of the Engineering Model, the SEM contractor shall construct breadboard models of electronic analog signal channels and perform laboratory tests of threshold stability, noise level and linearity. The tests shall be conducted at four or more temperatures, shall cover the

temperature ranges which will be encountered during qualification tests and in flight and shall cover the range of flux to be measured. The test(s) needs to be performed only on a worst case channel of each type in the system. In-process tests of electronic signal channels for the models shall be adequate to ensure compliance with the Technical Specification when the SEM is assembled.

b. Representative worst case feedback amplifiers of each type used in the SEM shall be tested in breadboard form to determine the margin of stability by measurement of the gains and phase margins within the loops.

c. If existing designs are proposed and prior data meeting this section 3.3.1.2 are available, these may be used without test with approval of the COTR.

d. For TS 3.1.5.5 the margin of rejection of power supply ripple shall be shown by test.

3.3.2 Electrical Interface Tests

a. Electrical harnesses shall be tested to verify that electrical signals are properly routed.

b. Before the integration of an assembly or component into the next higher hardware level, electrical interface tests shall be performed to verify that all interface signals are within acceptable limits.

c. All such tests, as well as the accompanying integration, shall be performed in an area that conforms to the cleanliness criteria developed in response to Section 9.

3.3.3 Tests on the Engineering Model

Tests with the Engineering Model shall be used, prior to completion of the design, for design verification and analysis.

3.3.3.1 Temperature Test at Ambient Pressure

The Engineering Model shall be tested at ambient pressure over a temperature range of X + 10 °C to Y - 10 °C where X and Y are taken from 3.6.2.1.

3.3.3.2 Magnetic Test

The SEM contractor shall design and conduct a magnetic test on the Engineering Model. The test shall map both the magnetic field and strength at the location of the TED entrance aperture and 1 m from the surface of each part of the SEM. The SEM contractor shall report details of the test and its results and show that the SEM meets the requirements of TS 3.8.14.

3.3.4 Performance Tests

3.3.4.1 Comprehensive Performance Tests

a. When all assemblies and components are integrated, a Comprehensive Performance Test (CPT) shall be conducted on each element. During environmental testing at a given level of assembly, comprehensive performance tests shall be conducted at least once during the hot and cold extremes of the temperature or thermal-vacuum test and at the conclusion of the environmental test sequence, as well as at other times that shall be defined in the Verification Plan. The initial CPT shall serve as a baseline with which the results of a later CPT's can readily be compared.

b. A comprehensive performance test is a detailed demonstration that, in any one, stated environment, hardware meets its performance requirements within allowable tolerances. The test shall demonstrate that all redundant circuits operate and that the hardware performs satisfactorily in all operational modes within practical limits of cost, schedule, and environmental simulation capabilities.

c. At the instrument level, the Comprehensive Performance Test shall demonstrate that when known stimuli are applied, the instrument will produce the expected responses. At lower levels of assembly, the test shall demonstrate that when appropriate stimuli are provided, internal performance is satisfactory and outputs are within acceptable limits.

3.3.4.2 Limited Performance Tests

a. Limited performance tests shall be performed before, during, and after environment tests, as appropriate, to demonstrate that each part of the environmental tests has not degraded the functional capability of the hardware. Limited performance tests shall also be used in cases for which comprehensive performance testing is not warranted or not practicable. Specific times at which limited performance tests will be performed shall be defined in the Verification Plan.

b. A limited performance test is a demonstration that hardware functions within acceptable limits in one, stated environment; less complete than a CPT.

3.4 STRUCTURAL AND MECHANICAL REQUIREMENTS

3.4.1 General Requirements

a. The contractor shall demonstrate compliance with structural and mechanical requirements with a series of interdependent test and analysis activities. The demonstrations shall verify design and specified factors of safety and ensure interface compatibility, acceptable workmanship, and compliance with applicable safety requirements.

b. If any failure occurs during either qualification or acceptance tests the COTR shall be immediately notified. At the discretion of the COTR a complete rerun of any test may be required.

3.4.2 Requirement Summary

Table 1 specifies the required structural and mechanical verification activities. When planning the tests and analyses, the contractor shall consider all expected environments, including those of structural loads, vibroacoustics, mechanical shock, and pressure profiles, and shall verify the mass properties and mechanical functioning.

The activities defined in Table 1 are for the case in which all elements of the instrument (including the electronics package) mount to the spacecraft as a single entity and can therefore be environmentally tested together. When that is not the case, each element of the instrument that mounts directly to the spacecraft shall be subjected to the "Instrument" test requirements of Table 1.

Table 1
Structural and Mechanical Verification Activities

Requirement	Level of Assembly	
	Instrument	Component
Structural loads	T	
Vibroacoustics		
Acoustics	T1	
Random vibration	T	T
Mechanical shock	T	
Mechanical function	T	
Pressure profile	A, T1	
Mass properties	A, T1	

T - Test required.
T1 - Test must performed if indicated by analysis or other considerations.
A - Analysis required.

3.4.3 Structural Loads

3.4.3.1 Load Qualification

a. Qualification for structural loads shall be by test or a combination of test and analysis. A vibration survey shall be conducted to verify that the lowest resonant frequency of the instrument is equal to or greater than 100 Hz.

b. Except as allowed here below, verify adequate instrument strength by applying loads equal to the qualification levels of Appendix D. After this the hardware must be capable of meeting the Technical Specification.
(Amend 4 B. 1.)

c. If appropriate development tests are performed to verify accuracy of the stress model and stringent quality-control procedures are invoked to ensure conformance of the structure to the design, then strength qualification for the accleration loads may be accomplished by a stress analysis which demonstrates that the hardware will meet its performance and safety criteria after being subjected to a load equal to 1.6 times the qualification test loads of Appendix D. The sinusoidal vibration test must still be performed, however.

d. When composite materials are used in the structure, analytic strength verification for acceleration loads may not be used. The wider ranges of strength associated with composite structures must be taken into account by additional demonstrations, such as development tests, proof-tests, and larger design factors. The use of materials that are susceptible to brittle fracture or stress-corrosion cracking requires the development of, and strict adherence to, special procedures to prevent problems.

e. Acceleration

1. In a centrifuge, the SEM shall be subjected to the acceleration loads listed in Appendix D (ref. TS 3.8.2, GIIS 3.7.3.3.4). The test shall be conducted as follows:

2. Before the SEM is exposed to acceleration, it shall be visually examined and shall be given, at least, a limited performance test. The SEM shall be rigidly attached to a mounting fixture where the mounting points shall simulate the spacecraft structure with regard to hole pattern, torque, preload and bolt size. The fixture shall be capable of attachment to the centrifuge so that the SEM can be accelerated for a duration of one minute for each orientation.

3. The SEM shall be unpowered during exposure to acceleration. Tests shall be conducted along the three principal axes in both the plus and minus directions.

4. After exposure to acceleration, the SEM shall be visually examined to determine if any detectable changes have taken place and shall be given a comprehensive perfomance test. Any out-of-tolerance performance shall mean failure to pass the acceleration test.

3.4.3.2 Load Acceptance -- Structural elements fabricated of composite material shall be tested to 80 percent of the qualification test levels of Appendix D. (Amend 4 B. 2.)

3.4.4 Vibroacoustics

3.4.4.1 Random Vibration -- Components shall be subjected to three-axis random vibration prior to instrument integration. For the instrument, random vibration shall be applied in each of the three orthogonal axes to the qualification levels of Appendix D. The level for the component tests shall be either: 1) that expected at the component mounting location during instrument test, or 2) the instrument levels, whichever is greater.

For acceptance test of previously qualified hardware, random vibration tests shall be conducted on the instrument at the acceptance levels of Appendix D. Random vibration tests shall also be performed on components. Levels shall be determined in the same manner as for the qualification test.

3.4.4.2 Acoustic Qualification -- The spacecraft with its payload, as part of its environmental testing sequence, will be exposed to an acoustic test as shown in Appendix D. The contractor shall review his instrument for large-area, low-mass components that would be exposed to, and could be affected by, direct acoustic energy. Such instruments may require an acoustic test in addition to the random vibration test to ensure proper operation during and after the launch phase.

3.4.4.3 Acoustic Acceptance -- Acoustic test is not required for acceptance of new hardware.

3.4.5 Mechanical Shock

3.4.5.1 Shock Qualification -- Both self-induced and externally induced shocks shall be considered in defining the mechanical shock environment. All instruments shall be exposed to all self-induced shocks.

By actuation of the shock producing devices, each device must be actuated a minimum of ten times in order to account for the scatter associated with different actuations of the same device. In addition, when the most severe shock is externally induced, a shock test shall be conducted on the instrument to the qualification levels of Appendix D.

3.4.5.2 Shock Acceptance -- Mechanical shock test requirements for the acceptance of previously qualified instruments are the same as the qualification requirements except that when the externally induced shock test is performed, the acceptance levels of section 2.2 of Appendix D shall be used. (Amend 4 B. 3.)

3.4.6 Mechanical Function

3.4.6.1 Design Verification -- Kinematic analyses of mechanical operations shall be conducted to ensure that the instrument performs satisfactorily and has adquate safety margins under worst-case conditions. In addition, testing of bearings, gears, balance mechanisms, etc. used in electromechanical systems shall be accomplished to verify proper performance and to establish baseline values for assembly elements prior to assembly tests.

3.4.6.1.1 Life Testing -- A life-test program shall be considered for mechanical elements that move repetitiously as part of their normal function and whose useful lifetime must be determined in order to verify their adequacy for the mission. In the Verification Plan, the contractor shall address the life-test program, identify the mechanical elements that require such testing, and describe the test hardware that will be used and the test methods that will be employed. For items for which it is determined that life testing is not required, the rationale for such deterination shall be provided along with a description of the analyses that will be conducted during the course of the program to verify the validity of such a determination.

3.4.6.2 Acceptance Requirements -- Testing of instrument mechanical operation is required at the nominal condition for the acceptance of hardware.

3.4.7 Pressure Profile

3.4.7.1 Qualification -- The need for a pressure profile test shall be assessed for all instruments. A qualification test shall be performed if analysis does not indicate a positive margin at loads equal to twice those induced by the maximum exected pressure differential during launch. If a test is required, the limit pressure profile shall be determined by the predicted pressure/time profile for the nominal trajectory of the particular mission. (ref. Appendix D) Because pressure-induced loads vary with the square of the rate of change, the qualification pressure profile shall be determined by multiplying the predicted pressure rate of change by a factor of 1.12 (the square root of 1.25, the required qualification factor on load).

3.4.7.2 Acceptance -- Pressure profile test requirements do not apply for acceptance of previously qualified hardware.

3.4.8 Mass Properties

The mass of each component shall be measured to within 5 g. The location of the center of mass of each component shall be measured to within 1.0 mm for each of the three orthogonal axes. (ref TS 3.1.11, 3.2.7, 3.3.6, 3.8.7 GIIS 3.2.1)

3.5 ELECTROMAGNETIC COMPATIBILIY

3.5.1 General EMC Requirements

The electromagnetic compatibility (EMC) of hardware shall be such that:

a. The instrument and its elements shall not generate electromagnetic interference (EMI) that could adversely affect its own components or the safety and operation of the spacecraft or the launch vehicle.

b. The instrument and its components shall not be susceptible to emissions that could adversely affect their safety and performance, regardless of whether the emissions are self-generated or derived from other sources or whether they are intentional or unintentional.

3.5.2 Specific EMC Requirements

The contractor shall demonstrate by test on the Engineering Model and on the Protoflight Model (ref. TS 3.6) compliance with the general requirements of section 3.5.1 by conducting an EMC program in accordance with Table 2. A test plan which outlines the SEM contractor's specific approach to EMI testing shall be submitted to the COTR for review prior to beginning the EMI tests. (ref. GIIS 3.6). Tests shall be done on the instrument and on the components. Not all tests apply to all levels of assembly or to all types of hardware. The specific requirements of each test listed in Table 2 are defined in Appendix D.

Table 2
EMC Requirements

Type of Test	Description	
Emissions	Conducted (powerlines)	Rf
	Radiated E-field (unintentional)	Rf
	Radiated H-field (ac)	Rf
Susceptibility	Conducted (dc powerlines)	Rf
	Conducted transient (powerline)	Rf
	Radiated E-field	Rf

Rf - Test to ensure reliable operation of spacecraft

The contractor shall impose more stringent requirements than those in Appendix D when necessary to meet the specific requirements of a mission. For example, an instrument with very sensitive electric field or magnetic field instruments may require more stringent test limits.

3.6 VACUUM, THERMAL, AND HUMIDITY

3.6.1 General Requirements

a. It shall be demonstrated that:

1. The instrument can perform satisfactorily in the vacuum and thermal environment of space.

2. The thermal design and the thermal control system can maintain the affected hardware within the mission allowable temperatures.

3. The hardware can withstand, as necessary, the temperature and humidity conditions of transportation and storage.

b. If any failure occurs during either qualification or acceptance tests the COTR shall be immediately notified. At the discression of the COTR a complete rerun of the test may be required.

c. Acceptance tests for components (magnets, foils, and detectors, etc.) shall ensure that the assembled sensors will be interchangeable and will meet the Technical Specification. Except for thermistors (ref. TS 3.4.5) it is acceptable if interchangeability includes a requirement for recalibration.

d. Thermistor signals sent to the spacecraft in analog form shall be calibrated in volts versus temperature. All analog variables shall be calibrated. All sensor test results shall be reported.

3.6.2 Thermal Validation

a. The thermal design shall be validated with an analytical model. The orbital environment that SEM instruments will experience on the spacecraft shall be simulated. All shields, insulation, radiative surfaces and temperature control provisions shall be included.

b. The thermal design shall be reported in conformance with Appendix E. The spacecraft contractor will use the design in a thermal simulation of the spacecraft. If a discrepancy appears, the SEM contractor shall adjust the design and the analytical model until a design satisfactory to both the SEM and the spacecraft is achieved.

c. After the thermal design is considered satisfactory the worst case maximum X and minimum Y temperatures determined shall be the mission allowable temperatures.

d. The final design shall be reported (ref. TS 7.2.8.5).

3.6.3 Thermal Vacuum; Qualification and Acceptance

a. The Engineering Model and the Protoflight Model shall be subjected to qualification, see Appendix D.

b. The Flight Models shall be subjected to acceptance, see Appendix D.

c. Temperature instruments shall be attached to the SEM in sufficient number and location as may be required to measure highest and lowest tempertures of critical items, and temperatures required for calibration purposes (e.g., A/D). These instruments shall not invalidate the thermal environment being measured.

d. The test chamber shall be controlled so that the bulk of the internal electronics reaches the temperature limits defined in the orbital simulation as X and Y.

e. Launch Phase Test

With power off and the SEM at ambient temperature, the chamber shall be evacuated at a rate simulating (but not exceeding) the launch pressure-time profile until a pressure less than 0.00133 Pa (1×10^{-5} torr) is reached. A twenty-four (24) hour stabilization and outgassing period shall elapse at this pressure before application of power and before proceeding with the Orbit Phase Test.

f. Orbit Phase Test

1. With the SEM operating and with a chamber pressure less than 0.00133 Pa (1×10^{-5} torr) the unit shall be subjected to the temperature cycling profile in Appendix D. In each of the first four (4) soak periods (2 high and 2 low), the SEM power shall be turned off, the SEM allowed to reach equilibrium and the power turned on to demonstrate restart capability.

2. The thermal-vacuum test data shall be examined to detect discrepancies in thermistor circuit calibrations and abnormal parts of these circuits shall be replaced.

3.6.4 Temperature - Humidity (Transportation and Storage)

Qualification -- A temperature-humidity analysis shall demonstrate that flight hardware that is not maintained in a controlled temperature/humidity environment will perform satisfactorily after (or, if required, during) exposure to the an uncontrolled environment with the following limits.

LIMITS: Humidity: 10% more (but not greater than 95%) and less than that for storage and transport.
Temperature: 15 °C higher and lower than for storage and transport.

If the SEM has restrictions on temperature or humidity these shall be stated.

3.6.5 Leakage

A leakage test shall demonstrate that leakage rates of sealed hardware are within the prescribed mission limits. Leakage rates shall be checked both before and after stress-inducing portions of the verification program to disclose any anomalies. The final test may be conducted during the final thermal-vacuum test. Test at the instrument level need include only those items that have not demonstrated satisfactory performance at the component level or that are not fully assembled until the higher levels of integration.

4. SYSTEM SAFETY

4.1 GENERAL REQUIREMENTS

The contractor shall plan and conduct a system safety program that provides for the identification and control of hazards to personnel, facilities, support equipment, and mission hardware and software during all stages of this procurement.

This program shall interface effectively with the industrial safety requirements of the contract and the contractor's existing safety organization.

4.2 SYSTEM SAFETY IMPLEMENTATION PLAN

The contractor shall prepare and submit a System Safety Implementation Plan (SSIP) that constitutes Section 4 of the Performance Assurance Plan (section 1.3). Contractor documents referenced therein shall be submitted with the SSIP.

The SSIP shall describe the safety program requirements and implementation procedures that the contractor will invoke to ensure the identification and control of hazards to personnel and hardware during fabrication, tests, transportation, ground activities, and launch.

4.3 PROCEDURE APPROVAL

Contractor safety personnel shall review all procedures that affect flight hardware for conformance with the SSIP. Hazardous operations shall be identified, and procedures for controlling them shall be approved by safety personnel.

4.4 OPERATION HAZARD ANALYSES

When the use of a facility or the performance of an activity could result in subjectng the instrument or personnel to hazards, an operation hazard analysis (OHA) shall be performed to identify the hazards and to document the requirements for either eliminating or adequately controlling each hazard. Operations that may require analyses include handling, transportation, functional tests, and environmental tests. A report of each OHA performed shall be submitted in accordance with Appendix A.

4.5 HAZARD-CONTROL VERIFICATION

The control of all hazards shall be verified by test, analysis, inspection, similarity to previously qualified hardware, or any combination of these activities. The contractor shall demonstrate that the required number of inhibits for eacn hazard is provided and that each inhibit is totally independent of the others.

5. PART CONTROL REQUIREMENTS 90-2-8

5.1 GENERAL REQUIREMENTS

The contractor shall plan and conduct a part control program in accordance with the requirements of this section. Under the program, only parts with acceptable, demonstrated performance and reliablity shall be used. When possible, only standard parts shall be used.

5.2 ELECTRICAL, ELECTRONIC, AND ELECTROMECHANICAL PARTS (EEE)

5.2.1 Standard Parts

Parts are standard EEE parts if they fall within the part types listed in MIL-STD-975 and the GSFC PPL and are not normally subject to further subdivision or disassmbly without destruction of designed use. Standard parts are acceptable if they are selected and procured in accordance with the Grade 1 quality level of the GSFC Preferred Parts List (PPL) (Appendix B). Applicable standard parts and part requirements from the Grade 1 quality level of the NASA Standard Parts List (NSPL) (Appendix B) are as specified in the PPL.

5.2.2 Nonstandard Part Control

Any part not defined in pararaph 5.2.1 as standard is considered to be a nonstandard part and shall be subject to nonstandard part control. Nonstandard parts shall be of a quality level consistent with that of standard parts. Nonstandard parts whose acceptability has been verified and that are procured and applied in accordance with requirements of the nearest applicable standard part may be used if prior approval is obtained. The rationale for selecting nonstandard parts and the supporting data attesting to the acceptability of the nonstandard parts for the application, both as to performance and reliability, shall be documented by the contractor. Contractor part engineers shall approve the selection, application, evaluation, and acceptance criteria for nonstandard parts. The Nonstandard Part Data Package shall be delivered to SEL in accordance with Appendix A. The package shall include at least the items of information listed on GSFC form 4-15, Nonstandard Part Approval Request.

a. Part Qualification -- Nonstandard parts shall be qualified either by similarity, by existing data, or by test and inspection results.
b. Hybrid Microcircuits -- Selection and approval of hybrid microcircuits that are not included in MIL-STD-975 (NASA) or the GSFC PPL shall comply with "Hybrid Microcircuit Requirements, Grade 1," GSFC Specification S-311-200 except that for those hybrids included in Alternate No. 2 of Panametrics's 10/27/87 Cost/Price Proposal the screening shall comply with said Alternate No. 2 as specified for "B-Plus Hybrids" and need not comply with S-311-200.

5.2.3 Derating

EEE parts shall be applied in accordance with the derating guidelines of the GSFC PPL. Applicable derating guidelines of the NSPL are as specified in the PPL. A derating policy other than that specified requires prior SEL approval and shall be submitted as part of the Performance Assurance Plan in accordance with Section 1 of Appendix A.

5.2.4 Part Specifications

A standard EEE part shall be procured in accordance with the specification designated for the part. All other parts shall be procured in accordance with military, NASA, or contractor-controlled specifications prepared in accordance with MIL-STD-490, paragraphs 3.2, 3.3, and 4.0 (Appendix A).

The specifications or drawings shall fully identify the item being procured and shall include the necessary physical, electrical, environmental, and screening requirements, as well as the quality assurance provisions that control manufacture and acceptance. EEE part screening requirements designated for the part shall specify test conditions, failure criteria, and lot-rejection criteria. The percent of defectives allowed in a screened lot shall be in accordance with that prescribed in the closest related military part specification.

5.2.5 Rescreening

All JANTX and JANTXV transistors and diodes shall be rescreened in accordance with the provisions of the GSFC PPL or MIL-STD-975 (NASA). Other approved EEE parts, which have, for example, military "established reliability," need not be rescreened unless indicated by one of the following conditions:

a. Receiving inspection results

b. Destructive physical analysis results

c. Alerts, SPL, or PPL requirements

d. Other factors such as special design drift tolerance

5.2.6 Destructive Physical Analysis

An internal destructive examination shall be performed on a decapped sample of each manufacturing lot or lot-date-code of microcircuits, hybrid microcircuits, and semiconductors. Destructive physical analysis (DPA) tests, procedures, sample size, and criteria shall be as specified in GSFC Specification S-311-70 (Appendix B). Any defects in any of the specimens as defined in S-311-70 shall be cause for lot rejection or a Material Review Board (MRB) action. Contractor DPA procedures and requirments may be used if they have been submitted to SEL in accordance with Appendix A.

5.3 PART AND DEVICE IDENTIFICATION LIST

An EEE part and device identification list shall be maintained and updated as changes occur. Parts and devices shall be listed by component, along with part/device name, manufacturer, part/device number, specification, and quantity required. Nonstandard parts and devices shall be specifically identified. The Part and Device Identification List shall be submitted to SEL in accordance with Appendix A.

5.4 RADIATION HARDNESS

Parts and devices shall be selected so as to meet their particular mission application in their expected radiation environment.

6. MATERIAL AND PROCESS CONTROL

6.1 GENERAL REQUIREMENTS

The contractor shall implement a comprehensive Material and Process Program, beginning with the design stage of the hardware. The program shall help ensure the safety and success of the mission through the proper selection and treatment of the materials of construction.

6.2 SELECTION REQUIREMENTS

6.2.1 Conventional Applications

Materials and procsses shall be selected on the basis of past performance, available data, or current tests. The contractor shall be guided by the applicable documents listed in Appendix B.

6.2.2 Nonconventional Applications

Any use of a material for which there is a lack of aerospace experience shall be considered a nonconventional application. Material for a nonconventional application shall be verified for the desired application on the basis of similarity, analysis, test, inspection, existing data, or a combination of these methods.

6.2.3 Special Problems

The contractor shall give special attention to problems such as radiation effects, stress/corrosion cracking, galvanic corrosion, hydrogen embrittlement, lubrication, contamination of cooled detectors, and weld-heat-affected zones. Critical high-strength fasteners and pressurized systems shall be reviewed from a fracture mechanics viewpoint before they are accepted for use.

6.2.4 Organic Materials

Materials shall be noncombustible or self-extinguishing and shall not generate toxic vapors. The outgassing characteristics of organic materials in vacuum shall be a prime consideration in selecting them. Only organic materials with a total mass loss (TML) of less than 1.00 percent and a collected volatile condensable material (CVCM) of less than 0.10 percent when tested in accordance with ASTM E595-77 (Appendix B) shall be used. (ref. TS 3.8.8.3)

6.2.5 Considerations in Process Selection

Manufacturing processes shall be carefully selected if they are the type that may substantially change a material's properties (e.g., heat instrument, welding, or chemical or metallic coatings). The objectives are to maintain the integrity of the materials and to avoid introducing property changes that could cause adverse effects.

6.2.6 Shelf-Life Controlled Items

In processes that involve polymeric materials whose uncured constituents have a limited shelf life (as indicated by the manufacturer's literature), some latitude will be granted for the use of date-coded expired materials if certain requirements are met. The contractor shall prove to SEL by means of appropriate tests that the properties of the materials have not been compromised for their intended use. The data from the tests must be submitted in accordance with Appendix A. Fabricated items such as "O" rings that have out-of-date codes shall not be installed in flight hardware.

6.3 MATERIALS REVIEW

A contractor materials engineer shall review the applications of the proposed materials and processes on the basis of engineering drawings before approving their use. He shall also audit and consult with all subtier contractors and vendors to assure himself that their materials and processes are acceptable for the applications involved.

6.4 MATERIAL AND PROCESS DOCUMENTS

The following information shall be submitted to SEL in accordance with Appendix A:

a. Data that supports nonconventional application.
b. Engineering drawings for material application.
c. Inorganic Material List -- This list shall be prepared and documented on GSFC form 18-59A.
d. Polymeric Material List -- This list shall be prepared and documented on GSFC form 18-59B
e. Lubrication List -- This list shall be prepared and documented on GSFC form 18-59C.
f. Material Process List -- This list shall be prepared and documented on GSFC form 18-59D

The contractor may use his own system of reporting if it provides all the information requested by the GSFC forms.

7. RELIABILITY

7.1 GENERAL REQUIREMENTS

The contractor shall plan and implement a Reliability Program that interacts with assurance programs for design, parts, materials, testing, and other space project activities. This section outlines the required elements of the Reliability Program. The contractor shall describe the methods for its accomplishment in the Performance Assurance Plan (section 1.3).

7.2 DESIGN ASSURANCE

7.2.1 Requirements

The contractor shall establish design criteria and shall standardize and control design practices. The designs shall be reviewed in accordance with section 2.5 and be capable of:

a. Functioning properly during the required mission lifetime

b. Minimizing or eliminating potential sources of human-induced failures

c. Permitting ease of assembly, test, fault isolation, repair, servicing, and maintenance without compromising safety, reliability, quality, and performance.

7.2.2 Assurance Personnel Support for Design Assurance

Contractor assurance personnel shall specifically ensure that:

a. The quality, reliability, safety, and maintainability considerations are factored into the design.

b. The design is capable of being inspected and tested and will facilitate repair.

c. The design is producible and repeatable.

d. The detailed design is in accordance with the controlling design criteria.

e. The performance, safety, and interface characteristics that require verification by analysis, inspection, and test are identified and reflected in appropriate lower-tier documents.

f. All processes and operations in which uniform high quality cannot be assured by inspection alone are identified, and controls are established to ensure quality.

7.2.3 Specifications, Drawings, and Test Procedures

7.2.3.1 Design Specifications -- The contractor shall write a design specification for each item of hardware at the instrument and component levels. Each design specification shall identify the physical and functional requirements and interfaces of the specified item.

7.2.3.2 Specification, Drawing, and Test Procedure Reviews -- The contractor's reliability organizaton shall review for concurrence all design specifications, drawings, and test procedures or shall ensure that they are independently reviewed before release. The review shall ensure that the documents cover all items of hardware at the appropriate levels, that each is complete in its contents, and that each is functionally and physically consistent with interfacing design specifications, drawings, and procedures. Reviews shall also be conducted for changes to the document.

7.3 RELIABILITY ANALYSES

7.3.1 Reliability Calculation

a. The SEM contractor shall produce and periodically update a reliability calculation.

b. The reliability calculation shall include:

1. a brief description of the operation of the device;
2. a mathematical model of reliability;
3. a reliability block diagram;
4. a schematic diagram;
5. a temperature and electronic worst-case stress analysis for each electronic part;
6. a reliability prediction based on the life specified in TS 5.5.
7. a calculation of what spares to provide and their number, giving the theory and method by which the spares and their number are chosen. Before procuring the spares (ref. TS 6.1) this calculation shall have received approval from the COTR.

8. development of clean area reqiurements better than that specified in PAR Section 8.10.3, if any. (Amend B. 5.)

c. The calculation shall be done using methods reviewed and approved by the COTR. Failure rates for parts listed in PPL-17 (ref. Appendix B p. B-3) shall be adjusted for actual use conditions. Failure rates of items not listed shall be submitted to the COTR.

7.3.2 Failure Mode, Effects, and Criticality Analysis

a. A Failure Mode, Effects, and Criticality Analysis (FMECA) shall be performed at the instrument/component and the spacecraft/instrument interfaces to identify potential critical and catastrophic failures so that susceptibility to the failures and their effects can be minimized. The analysis shall be performed early in the design phase for all electrical and electromechanical flight hardware. Potential instrument/component interface

and spacecraft/instrument interface critical and catastrophic failures shall be analyzed to the extent necessary to identify single elements that could cause the failures. These interface analyses shall ensure that no single failure will affect spacecraft performance.

b. Analysis of any redundant equipment shall address cross-strapping to ensure that no single failure will adversely affect the performance of the redundant capability.

c. Potential critical and catastrophic failures that cannot be eliminated from the system shall be itemized on a Critical Item List that shall be attached to the FMECA. Justification for the retention of each item listed shall be included. The FMECA, together with the attached Critical Item List and updates, shall be submitted to SEL in accordance with Appendix A.

7.3.3 Part and Device Stress Analyses

EEE parts and devices as applied in circuits within each component shall be subjected to stress analyses for conformance with the derating guidelines of MIL-STD-975 and the GSFC PPL (paragraph 5.2.3). The analyses shall be performed at the most stressful part-level parameter values that can result from the specified performance and environmental requirements on the assembly or component. The analyses shall be performed in close coordination with the packaging reviews (section 2.5) and shall be required input data for component-level design reviews (section 2.5). The stress analyses shall be documented and updated as stated in Appendix A.

7.3.4 Worst-Case Analyses

Worst-case analyses shall be performed for critical parameters that are subject to variations that could degrade performance. Adequacy of margins in the design of electronic circuits, optics, and electromechanical and mechanical items shall be demonstrated by analyses and/or test. The analyses shall consider all parameters set at worst-case limits and worst-case environmental stresses for the parameter or operation being evaluated. The analyses shall be updated as part of design changes. On request, both the analyses and updates shall be made available to SEL.

7.3.5 Trend Analyses

The contractor shall assess the instrument and its components to determine the measurable parameters that relate to performance stability. These parameters shall be monitored for trends starting at initiation of acceptance testing and continuing during the integration and test phases of the instrument. The parameters shall be monitored within the normal test framework (i.e., during functional tests, environmental tests, etc.). The contractor shall establish a system for recording and analyzing the parameters and any changes from the nominal, even if the levels are within specified limits. A list of parameters to be monitored and the trend analysis reports shall be submitted in accordance with Appendix A.

7.4 LIMITED-LIFE ITEMS

Limited-life items shall identified on a Limited-Life List which shall be submitted in accordance with Appendix A. The list shall include the expected life and the rationale for selecting each item. Limited-life items include all hardware that is subject to degradation because of age, operating time, or cycles such that its expected useful life is less than twice the required life when fabrication, test, storage, and mission operation are combined.

7.5 RELIABILITY OF GOVERNMENT-FURNISHED PROPERTY (GFP)

When the overall system includes components furnished by the government, the contractor shall be responsible for obtaining from SEL adequate reliability data on the items. The data will be used for performing the FMECA. When the contractor's examination of the data or testing indicates that the reliability of GFP is inconsistent with the reliability requirements of the overall system, SEL shall be formally and promptly notified.

8. QUALITY ASSURANCE (QA)

8.1 GENERAL REQUIREMENTS

The contractor shall establish, document, and ensure compliance with design control requirements and quality criteria during all phases of contract work. In the Performance Assurance Plan (section 1.3), the contractor shall set forth his methods for meeting the QA requirements of the project during all of its phases. The plan shall ensure that controls are carried out according to schedule. SEL shall be kept informed of the status of QA by the submittal of reports in accordance with section 1.6.

8.2 CONFIGURATION MANAGEMENT

8.2.1 Program and Plan

The contractor shall establish and maintain a configuration management (CM) program based on the requirements of DOD-STD-480A, GSFC S-480-17, this PAR and the plan approved at contract award. As a minimum, the final plan, approved prior to contract award, shall address the following: (1) a brief description of the contractor's configuration management system and change control system with a flow chart; (2) an orderly and well defined method of ensuring that approved changes are incorporated into hardware and/or software; (3) quality assurance participation in the change control system; (4) SEL review and approval of contractor-proposed changes; and (5) deliverable CM documents listed in Appendix B. The CM plan shall be in force throughtout the life of the contract. Configuration control shall be fully in effect at the end of the CDR notwithstanding S-480-17 1.4.

8.2.2 Classification of Changes

Proposed changes that require either review or approval by SEL and, through SEL, the GSFC METSAT Project Configuration Control Board (CCB) shall be classified as follows:

a. Class I Change -- Requires, through SEL, GSFC approval. Any change that affects the Technical Specification or the spacecraft, technical interface, or cost and schedule requirements is defined as a Class I change.

b. Class II Change -- Requires, through SEL, GSFC review. A change is Class II when it does not fall within the definition of Class I change. Class II changes do not require SEL or GSFC concurrence before implementation. Examples of Class II changes are changes in documentation only (e.g., correction of errors, addition of clarifying notes or views) or change in hardware that does not affect any factor listed under Class I changes.

Class I changes originated by the contractor and subcontractor shall be documented on METSAT Configuration Change Request, GSFC 480-39A, and shall be submitted to SEL for approval before implementation. These changes shall be numerically ordered. Class II changes originated by the contractor and approved by the contractor's CCB shall be submitted on the contractor's internal change forms for SEL review.

8.2.3 Configuration Management Documents

Configuration management program status reports shall be submitted by the contractor as as part of the monthly Status Report. Documents shall be submitted in accordance with Appendix A. These shall be subject to action by SEL as indicated.

8.2.4 Configuration Verification

Assurance personnel are required to verify that the as-built product complies with the applicable as-designed configuration and that it is in accordance with approved configuration documents as required by the Configuration Management Plan and with sections 8.3, 8.4 and 8.18. The configuration shall be maintained and controlled throughout the contract.

8.2.5 Support of Design Reviews

Quality assurance personnel shall participate, as described in section 7.2.2, in reviews (sections 2.3 and 2.5).

8.3 DOCUMENT CHANGE CONTROL

The contractor shall ensure the control of all documents and changes thereto that affect the mission hardware and software. Quality assurance personnel shall ensure that documents and changes are controlled in accordance with the contractual configuration management requirements. The contractor shall ensure that the effectivity of documents and changes are clearly specfied, changes are accomplished on affected elements, and changed elements are appropriately identified. Documents shall be kept current, and all fabrication, inspections, and tests shall be performed according to the applicable drawings and changes. The inspection record of the product shall indicate the change level with which it is in compliance.

The issue numbers of the drawings and specifications to which the particular hardware has been fabricated, inspected, and tested shall be documented as the as-built configuration. Evidence shall be provided of compliance with the as-built documents as a basis for acceptance of the hardware. This information shall be submitted as part of the Acceptance Data Package (section 8.22).

A contractor QA representative shall be a member of the contractor's board that controls configuration changes.

8.4 IDENTIFICATION AND TRACEABILITY

8.4.1 Requirements

The contractor shall maintain a product identification and tracking system. Each product shall be identified by a unique part or type number, consistent with the configuration management system or the contract. Where control of individual products or lots of products is required, date codes, lot numbers, serial numbers, or other identification shall be used as appropriate. Serial numbers and lot numbers shall be assigned in consecutive order.

The configuration management system shall be capable of retrieving the identification and serialization record at the subassembly level. Beginning at the subassembly level and continuing through the end product, the system shall be capable of tracing backward to the originating subassembly and forward to the location of the subassembly at any given level of process, assembly, or test. Identification and serialization data lower than those for subassemblies shall be maintained in the manufacturing and processing records and shall contain date code, lot numbers, and manufacturer of the item. The contractor is encouraged to make use of his existing identification and traceability system. Serial numbers of scrapped products shall not be reused.

8.4.2 Identification List

The contractor shall maintain an Identification List with reference to contractor-designed and supplier-designed products. The list shall indicate the part or type number and the group and individual identification. The list shall be a part of the configuration management system, and changes shall be in accordance with section 8.3.

8.5 PROCUREMENT CONTROLS

The following detailed quality assurance requirements shall be included or referenced in the procurement documents, as applicable, in addition to those requirements selected in conformance with section 1.8.2.

8.5.1 Product Changes

The supplier shall notify the contractor of proposed changes to products (including changes in design, fabrication methods or processes, and changes which may affect the quality or intended end use of the item). The supplier shall submit these changes to the contractor for processing in accordance with the contractor's Configuration Management Plan. Even when the contractor procures a proprietary item, the supplier shall notify the contractor of such changes.

8.5.2 Purchased Raw Materials

Raw materials purchased by the contractor shall be accompanied by the results of chemical and physical tests or a certificate of compliance. When material is purchased for critical design applications, the supplier shall be required to furnish specimens for chemical and physical tests.

8.5.3 Raw Materials Used in Purchased Products

The supplier shall document and make available to the contractor on request the results of acceptance tests and analyses performed on raw materials.

8.5.4 Age Control and Limited-Life Products

Records shall be kept on products that have definite characteristcs of quality degradation or drift with use or age. The records shall note the date, test time, or cycle when useful life was initiated, the life or cycles used, and the date and test time or cycle when useful life will be expended.

8.5.5 Inspection and Test Records

The contractor shall specify that the supplier maintain inspection and test records as evidence of inspection and test results. The contractor shall also specify records that are to be provided with the deliverable item.

8.5.6 Government Source Inspection (GSI)

When the government elects to perform inspection at a supplier's plant in accordance with section 8.7, the following statement shall be included in the procurement document:

> "All work on this order is subject to inspection and test by the government at any time and place. The government quality representative who has been delegated NASA quality assurance functions on this procurement shall be notified immediately upon receipt of this order. The government representative shall also be notified 48 hours in advance of the time that articles or materials are ready for inspection or test."

8.5.7 Procurements That Do Not Require GSI

Procurements that do not require GSI shall include the following statement:

> "The government has the right to inspect any or all of the work included in this order at the supplier's plant."

8.5.8 Contractor QA Activity at Source

When contractor QA activity is required at a supplier's plant as determined by section 8.8, the procurement document shall so indicate.

8.5.9 Resubmission of Nonconforming Articles or Materials

Nonconforming articles and materials returned to the supplier by the contractor and subsequently resubmitted by the supplier shall bear adequate identification of such resubmission. Reference shall be made to the contractor's nonconformance document, and evidence provided that the causes for the nonconformance have been corrected and actions have been taken to preclude recurrence.

8.6 REVIEW AND APPROVAL OF PROCUREMENT DOCUMENTS

Quality assurance personnel shall review and approve procurement documents before they are released to ensure that applicable requirements of this document are included. These reviews shall be documented.

8.7 GOVERNMENT SOURCE INSPECTION

The contractor shall forward procurement documents to the government representative for review so that he can ensure compliance with controlling documents and determine the need for GSI. Such government inspection shall not replace contractor source inspection or relieve the contractor of his responsibilties for product reliability, quality, and safety.

8.8 CONTRACTOR SOURCE INSPECTION

The contractor shall perform source inspection at the subcontractor's or supplier's facilities when directed by the procurement documents or when one or more of the following conditions exist:

a. In-process, end-item controls, or tests that are destructive in nature prevent the contractor from verifying quality in his plant.

b. It is not feasible or economical for the contractor to determine the quality of procured articles solely by inspections or tests performed at his plant.

c. Qualification tests are to be performed by the subcontractor or supplier.

d. Products are shipped directly from the source to user, by-passing the contractor's inspection facilities.

8.9 CONTRACTOR RECEIVING INSPECTION

A controlled, documented receiving inspection system that covers all purchased products is required to ensure compliance with procuremnt documents.

All procured products shall be processed through an incoming inspection and testing system before fabrication. Nondestructive evaluation (NDE) may be used if controlled documentation and certified personnel are employed. The receiving/inspection system shall consist of the following:

a. Procured products shall indicate evidence of inspections and tests performed by the suppliers in accordance with the purchase requirement and shall be accompanied by the required data directly traceable to the products. The records shall give evidence of contractor and Government source inspection.

b. Inspections and tests shall be conducted in accordance with written procedures on selected characteristics of the products to verify their acceptability. Particular emphasis shall be placed on the selection of characterstics that have not been contractor-source inspected and those for which nonconformances are difficult to detect during subsequent inspection and test. Test results shall be compared on a sample basis with test results provided by the supplier. Disassembly shall be performed periodically for detailed verification when required by the procurement document or the procedures.

c. The supplier's age control and limited-life product records shall be updated to reflect the receiving inspection activity.

d. When required by procurement documents, chemical and physical tests shall be conducted on supplier-furnished specimens or on randomly selected samples of material having critical design applications. When acceptance is based on a supplier's certificate of compliance (COC), chemical analyses or physical tests shall also be conducted on randomly selected samples from each lot of materials to verify the COC.

e. Products and their records shall show acceptance or nonconformance status when released from receiving inspection, and the products shall be protected for subsequent handling or storage. Nonconforming products shall be submitted for MRB action (ref. 8.12.1.3). Items awaiting inspection results or test results shall be identified.

f. Sampling inspection shall be made of items such as nuts, bolts, and fasteners that are not used as critical attachments (section 8.17).

g. Receiving inspection and test records shall be maintained, including copies of documents submitted by the supplier.

h. Assurance that the electrostatic discharge control plan (section 8.11) is being complied with during receiving inspection shall be provided.

8.10 FABRICATION CONTROL

8.10.1 Fabrication and Assembly Flow Plan

In addition to the general performance assurance requirements set forth in Section 1 (section 1.3 through 1.9), the contractor shall develop a Fabrication and Assembly Flow Plan that covers all operations (from start of fabrication to delivery), including the inspections and tests, GSI points, and all special processes to be used. A preliminary flow plan and a final flow plan shall be submitted in accordance with Appendix A.

89-3-16

8.10.2 Documents

The contractor shall use a document system (consisting of items such as fabrication orders, assembly orders, shop travelers, and repair procedures) to control the flow of hardware through manufacturing. Controls shall ensure that only conforming product is released and used during fabrication and that those not required for the operation involved are removed from the work area and properly stored. Traceability shall be maintained in accordance with section 8.4. Fabrication documents shall include or reference:

a. Nomenclature and identification of the element

b. Tooling, jigs, fixtures, and other equipment to be used

c. Characteristics and tolerances to be obtained

d. Detailed procedures for controlling processes

e. Special conditions to be maintained, such as environmental conditions or precautions to be observed

f. Workmanship standards

g. Controls for parts, materials, and articles that have definite characteristics of quality degradation or drift with age, including requirements for recording and maintainin dates, time, or cycles for determining end of life

h. Traceability to the individual performing each fabrication and assembly operation

Contractor assurance personnel shall ensure that manufacturing operations are in compliance with up-to-date controlling documents.

8.10.3 Fabrication Requirements

All fabrication, assembly and handling of elements shall be done in Class 100,000 or better clean areas in accord with the Fabrication and Assembly Flow Plan, 8.10.1. The requirements of NHB 5300.4(3A-1) (Appendix B) shall be implemented. Workmanship standards may be used that show acceptance critria. When display standards showing acceptance criteria are necessary, they will be jointly selected by the contractor and by SEL or its quality representaive. Standards shall be kept current and shall be used to train, certify, and recertify personnel who perform critical operations and operations that cannot be fully verified without destructive disassembly or test. (Amend 4 B. 5.)

Clarification - Performance Assurance Requirements, SEL 86-2 Section 8.10.3 Fabrication Requirements applies to "fabrication" under 8.10 and not to other operations or activities under PAR SEL 86-2, notwithstanding the use of the word "handling" in Section 8.10.3 which in 8.10 applies to handling during fabrication. (Amend 4 C.)

87-12-28

8.10.4 Process Evaluation and Control

Controls shall be implemented for processes for which uniform high quality cannot be ensured by inspection of products alone. NDE methods may be used if controlled documents and certified personnel are employed. Process procedures shall be prepared and shall describe the following:

a. Preparation of the processing equipment, solutions, and materials

b. Preparation of the products to be processed

c. Detailed processing operations

d. Conditions to be maintained during each phase of the process, including environmental controls

e. Methods of verifying the adequacy of processing materials, solutions, equipment, environments, and their associated control parameters

f. Inspection and test provisions

g. Records for documenting the results of process inspection, test, and verification

The contractor shall provide for the certification of equipment used in selected processes. Records that certify test results shall be maintained. Equipment shall be recertified as indcated by the results of quality surveys, inspections, or tests, or when changes are made that may affect process integrity.

8.11 ELECTROSTATIC DISCHARGE CONTROL

The contractor shall develop and implement an Electrostatic Discharge Control (EDC) Plan that will ensure that ESD-sensitive flight hardware is protected during assembly, testing, and handling. The scope of the EDC plan shall be as contained in Sections 1 through 6 of Jet Propulsion Laboratory (JPL) document PD-625-263 (Appendix B). The plan shall be submitted in accordance with Appendix A.

8.12 NONCONFORMANCE CONTROL

The contractor shall operate a closed-loop nonconformance control system for failures and discrepancies. The system shall include provisions for the following:

a. Documentation of each nonconformance traceable to the specific product on which it occurred

b. Assignment of a unique and traceable document number for each failure and for those discrepancies designated for Material Review Board (MRB) action

c. Description of the nonconformance and the required characteristic or design critria

d. Conducting and documenting analyses and examinations to determine the cause

e. Conducting and documenting timely and effective remedial and preventive action on the products and applicable documents

f. Disposition of the nonconforming product

g. Signatures of authorized personnel on the appropriate nonconformance documents

h. Accumulating data in summary reports

i. Performing analysis from the part level of assembly and higher to identify adverse trends and to provide for their correction

j. Closeout of nonconformance documents after verifying that effective remedial and preventive actions have been taken

On request, a report of the analyses required by items d and i shall be made available to SEL. Products that depart from specified requirements shall be identified and, if practicable, shall be isolated for review action. The system shall include provisions for controlling nonconforming products that cannot be isolated from the normal channels of manufacture.

If failure reporting is covered in the Reliability Section (Section 7) of the Performance Assurance Plan, it shall describe how the responsilities and procedures interface with quality assurance. The discrepancy and failure-control sections of the plan shall be cross-referenced.

8.12.1 Control, Disposition, and Reporting of Discrepancies

8.12.1.1 Documents -- Control of discrepancies shall begin with the receipt of procured parts, materials, or other elements or with the initiation of in-house manufacturing, whichever occurs first. Each discrepancy shall be documented on the appropriate contractor form as soon as it is discovered.

8.12.1.2 Initial Review Dispositions -- Discrepant products shall be reviewed by contractor QA and engineering personnel as appropriate and shall be subjected to one of the following dispositions:

a. Return for Rework or Completion of Operations -- The product shall be returned together with established and approved documents and operations. During rework, the product shall be resubmitted to normal inspection and tests.

b. Scrap in Accordance with Government-Approved Contractor Procedures

c. Return to Supplier -- The product shall be returned for replacement. The contractor shall provide the supplier with the nonconformance information assistance that is necessary for remedial and preventive action. (Note: return to supplier for other than replacement is a. above.)

d. Submit to Material Review Board -- When the dispositions described above are not appropriate, the discrepant products shall submitted to the MRB for final disposition.

Products disposed of without referral to the MRB shall be subject to review by the government quality representative. Initial review dispositions shall be recorded on nonconformance documents.

8.12.1.3 Material Review Board -- MRB decisions on nonconformance shall be submitted to SEL in accordance with Appendix A. Other provisions of the MRB are as follows:

a. Membership -- As a minimum, the MRB shall be composed of the following members:

(1) Contractor quality representative (chairman)
(2) Contractor enineering representative
(3) Government quality representative

The contractor shall select members on the basis of technical competence. The government representative on the board shall have review authority on board membership.

b. Responsibilities -- The MRB shall have the responsibilty to:

(1) Determine disposition of submitted products. Note that all MRB decisions must be unanimous. (ref. 8.12.2.2)

(2) Ensure that remedial and preventive actions, including reinspection and retest requirements, are recorded on the nonconformance document before disposition.

(3) Perform trend analysis of discrepancies.

(4) Ensure that MRB records are maintained.

c. Dispositions -- In addition to the dispositions listed in section 8.12.1.2, the MRB shall have authority for the following:

(1) Repair -- The MRB shall approve repairs except as follows: Standard repair procedures shall be submitted to SEL in accordance with Appendix A. The MRB shall authorize the use of the procedures for each instance of repair. The MRB shall ensure that the hardware reliability and quality are not compromised by excessive repairs.

(2) Scrap

(3) Use-As-Is -- Submit a request in accordance with Appendix A except as follows:

(a) MRB disposition shall not adversely affect the safety, reliability, durability, performance, interchangeabilty, mass, or other basic features of the hardware.

(b) Dispositions that, in the opinion of the MRB, will adversely affect any of the foreoing or that are contrary to any of the requirements of the contract, must be submitted as a waiver request to the contracting officer for approval in accordance with the Configuration Management Plan, (section 8.2 and Appendix A).

(c) The products shall be withheld from further processing in a controlled area until direction for disposition is given by the contracting officer.

8.12.1.4 Supplier Material Review Board -- With approval of SEL or its authorized quality representative, the contractor may delegate MRB responsibility to suppliers.

8.12.2 Control, Reporting, and Disposition of Failures

8.12.2.1 Failure Reporting -- A malfunction or failure report shall be written for any departure from design, performance, testing, or handling requirements that affect the function of flight or ground equipment or could possibly compromise mission objectives.

All other problems or anomalies that are unusual or that might affect other areas shall be cited on a malfunction or failure report.

After the Engineering Model, reporting of hardware failures shall begin with the first power application at the lowest level of assembly or the first operation of a mechanical item. For software items, use of this failure reporting system shall begin with the first test use of the software item with a hardware element of the mission system at the component level or higher. Reporting shall continue through formal acceptance by SEL.

a. Report Processing -- A malfunction or failure report shall be initiated immediately after a failure has occurred. (See form 8 for a sample report form.) The contractor may use his existing form for reporting if it complies with the requirements of the GSFC Malfunction Report form.

The report shall be submitted to SEL in accordance with Appendix A, and the identical information shall be given to the in-plant government quality representative.

The contractor shall maintain a master report file that contains all supplementary data, such as failure analysis and records of meetings.

b. Status Summaries -- A summary of the open malfunction or failure reports shall be submitted as part of the Performance Assurance Status Report (section 1.6). The summaries shall list each problem or failure as a separate line item and shall provide complete identification of the affected hardware (part and serial numbers), the environment, date of occurrence, and a brief description of the failure, its cause, and the corrective action to be taken.

8.12.2.2 Failure Review Board -- A Failure Review Board (FRB) shall be established and, as a minimum, shall be composed of the following:

a. Contractor quality representative (chairman)
b. Contractor project manager or his representative
c. Contractor engineering representative who is responsible for the failed item

The FRB shall investigate, analyze, and determine the cause of all failures. Investigations and actions shall be coordinated with SEL and shall be documented on a malfunction or failure report. Trend analysis shall be performed, and corrective action shall be taken. When it is determined that the affected item is discrepant, the FRB will refer it to the MRB for disposition in accordance with section 8.12.1.3. If required, configuration changes shall be in accordance with section 8.2. Decisions of the FRB must be unanimous. Closeout of each failure shall require verification that remedial and preventive actions have been accomplished in the system hardware model on which the failure occurred, that necessary preventive design changes in hardware and software have been accomplished and verified in test, and that effectivity of preventive actions has been established in other existing identical items of hardware and software. The FRB chairman, denoting completion of closeout actions and approval by the entire Board, shall sign the malfunction or failure report closeout before submitting it to SEL (Appendx A).

8.13 ALERT INFORMATION

GSFC will provide the contractor with Alerts that document problems with parts, materials, processes, and safety as reported through the Government-Industry Data Exchange Program (GIDEP). In accordance with Appendix A, the contractor shall submit Responses to Alerts, which inform SEL of the applicability of the problem to project hardware and any follow-up action proposed. Status summaries that cover each Alert received in a 30-day period

shall be submitted as part of the Performance Assurance Status Report (section 1.6).

The contractor shall prepare Alerts on problems that are within the scope of the Alert and safety system. If the contractor partipates in the GIDEP, he shall submit a copy of the Alert to SEL. If he does not participate in the GIDEP, he shall prepare Alerts (DD Form 1938, attachments 12 and 13) and submit them, together with supporting data, to SEL in accordance with Appendix A. Quality assurance personnel shall ensure compliance.

8.14 INSPECTION AND TEST

The contractor shall plan and conduct an inspection and test program for demonstrating that contract, drawing, and specification requirements are met. Inspections and tests shall be performed on products before they are installed in the next level of assembly. These inspections shall include a review of product records. Each inspection and test shall be traceable to the individual responsible. Quality assurance personnel shall approve all manufacturing documents before they are used.

8.14.1 Planning

The contractor shall plan for inspections and tests and for a document system that substantiates their accomplishment. The planning function shall provide for:

a. Orderly and timely inspection and tests at the earliest opportunity and throughout all phases

b. Coordination and sequencing of inspection and tests conducted at successive levels of assembly to ensure satisfactory articles and materials and to eliminate unnecessary testing

c. Availability of calibrated inspection and test equipment

d. Coordination of inspections and tests conducted by the designated Government Quality Representative

8.14.2 Inspection Procedures

Inspection shall be conducted in accordance with documented procedures physically located at the applicable inspection station. The degree of detail in the inspection procedure shall be commensurate with the complexity of inspection operations. Inspection procedures may be a part of the manufacturing control documents. Procedures shall include, as applicable, the nomenclature of the article, characteristics to be inspected, accept/reject criteria, and special consideration regarding measuring equipment, standards, safety, and environment.

8.14.3 Inspection Activity

As a minimum, the inspections in the following sections shall be performed.

8.14.3.1 In-Process Inspection -- In-process inspection shall be performed at all levels of assembly in keeping with the following requirements:

a. The configuration, drawing requirements, and workmanship shall be verified before the next step of fabrication or integration. Characteristics shall be verified that cannot be verified later without destructive disassembly.

b. In-process inspection shall be done in a clean environment in accordance with the Contamination Control Plan (ref. 9.1).

c. In-process inspection personnel shall be certified for selected processes and inspections.

d. In-process verification below the component level shall include electrical interface tests (section 3.3.1) of subassemblies and assemblies prior to being integrated into the next higher level of hardware.

8.14.3.2 Final Inspection -- Final inspection shall be performed at all levels of assembly as follows:

a. Configuration, workmanship, and test results shall be verified before installation or use with the next higher level of assembly.

b. Assurance personnel shall verify that all nonconformances have been processed and all open items have been transcribed into the next level of inspection or fabrication documents.

c. Same as 8.14.3.1b.

d. Same as 8.14.3.1c.

8.14.3.3 End-Item Inspection -- End-item inspection shall be performed to:

a. Verify that configuration, test results, workmanship, and the Acceptance Data Package are in compliance with the contract.

b. Verify that SEL has authorized the delivery of the end-item with any open nonconformances and unresolved tasks that may exist.

8.14.3.4 Surveillance Inspection -- Stored and stocked parts, materials, and flight or spare hardware shall be periodically inspected and tested for proper storage environment and packaging to prevent deterioration or damage. The contractor shall identify the hardware and the frequency of the inspection in the Performance Assurance Plan.

8.14.4 QA Activities During Integration and Test

Assurance personnel shall ensure that the subassemblies, assemblies, components, and contract end-items are integrated and tested in accordance with controlling documents. Articles undergoing test shall not be adjusted,

modified, repaired, reworked, or replaced except as specified in established documents, or in accordance with MRB actions. The status, configuration, and integrity of the hardware must be maintained and documented. Test activities shall be conducted in a clean area in accordance with the Contamination Control Plan.

Assurance personnel shall provide surveillance of all tests, the extent of which shall be defined in QA and test documents by quality assurance management. As a minimum, the actvities in the following paragraphs shall be performed.

8.14.4.1 Verification -- Before testing, the assurance personnel shall verify:

a. The presence of approved inspection and test documents
b. The identification of products
c. The configuration of products
d. That test equipment is within the calibration period for the duration of the test
e. Test setup and test configuration

8.14.4.2 Test Documentation -- During tests, the assurance personnel shall:

a. Ensure that tests are conducted in accordance with approved specifications and procedures.

b. Ensure accurate and complete recording of data and results.

c. Document rework, repairs, or modifications.

d. Document nonconformances.

8.14.4.3 Post-test Assurance -- Subsequent to testing, the assurance personnel shall:

a. Ensure proper disposition of articles.

b. Verify that test results, reports, and nonconformance documents are accurate, complete, and traceable to the tested products. Any additional nonconformances shall be processed in accordance with section 8.12.

8.14.5 Inspection and Test Records (Component Level to End-Item)

8.14.5.1 General Requirements -- The contractor shall prepare and maintain records, including logs, of all inspections and tests to show that all operations have been performed, that objectives have been met, and that end-items have been fully verified.

8.14.5.2 Scope -- Records shall cover each subassembly, component, and instrument. As the hardware is integrated, records of lower level assembly products shall be combined into those for the end item as a means of compiling

2) Width: Equal to that of the text pages, or a multiple thereof, with foldaway. 90-1-10

7.4 Check Plan

The Check Plan of 4.7 shall be prepared by the SEM contractor after consultation with the COTR. It shall be submitted to the COTR for review at least forty five (45) days prior to its initial use.

7.5 Photographs

7.5.1 General

The SEM contractor shall provide photographs of the SEM, its assemblies, and ground support equipment. The SEM contractor shall furnish a 35 mm slide and four 8 x 10 inch glossy prints of each photograph. All photographs shall be in color and shall include a metric scale.

7.5.2 SEM Photographs

A minimum of six (6) views illustrating each unit in the Protoflight SEM are required. These shall show the SEM both in final form and partially disassembled. Separate photographs shall be staged, show as many details as practical, and show the relationships of the various assemblies.

7.5.3 GSE Photographs

These photographs shall be staged to aid in planning the installation and use of the GSE.

7.6 Management Documents

7.6.1 Project Organization Chart

The SEM contractor shall provide a detailed project organization chart showing the assignments of key personnel such as the project manager, mechanical and electronic engineers, and quality/reliability personnel. This chart shall be maintained and updated throughout the contract as part of PAR 1.6 b.

7.6.2 Project Plan

Within thirty (30) days after contract award, the project plan submitted as a part of the SEM contractor's proposal shall be refined by adding a work breakdown structure and a cumulative expenditure curve. The SEM contractor shall prepare the Work Breakdown Structure (WBS) through level III (ref. Handbook for Preparation and Implementation of Work Breakdown Structure GHB7120.1). The WBS shall be updated throughout the contract.

7.6.3 Work Plan

The work plan submitted as a part of the SEM contractor's proposal shall be routinely updated and reported monthly in one of the weekly reports. The work plan shall provide for PERT and critical path information to allow control of the work, to allow adjustments and to allow knowing the effect of adjustments.

b. Stamps shall be traceable to the individual responsible for their use, and records shall be maintained to identify the individual. Fabrication (manufacturing) and inspection stamps shall be of different designs.

c. Stamps shall be applied to records to indicate the fabrication or inspection status of the products.

8.17 SAMPLING PLANS

Sampling plans may be used when inspections or tests are destructive or when data, inherent characteristics, or noncritical application of a product permits a reduction in inspection or testing. Such plans shall not jeopardize quality, reliability, or design intent. MIL-STD-105 (Appendix B) shall be used for establishing the sampling plan requirements. The sampling plan shall provide an average quality level that is appropriate to the reliability requirements of the project. Sampling plans shall be identified in the applicable inspection procedures.

8.18 SOFTWARE ASSURANCE

The contractor shall develop and implement software assurance controls. As a minimum, these shall include a design presentation method, coding standards, configuration management, test planning, and error reporting. Contractor assurance personnel shall ensure that these controls are implemented and carried out and that the software's performance has been validated according to approved test plans before use with the flight and support hardware. Software nonconformance after integration shall be documented in accordance with section 8.12.

8.19 TRAINING AND CERTIFICATION FOR MANUACTURING AND INSPECTION PERSONNEL

8.19.1 Training

The contractor shall use trained personnel for implementing the performance assurance program and process control. Training programs shall be developed, documented, implemented, and maintained for personnel who may have an effect on or who are responsible for reliability and quality.

8.19.2 Certification and Recertification of Personnel

a. Certification -- Contractor personnel who control selected processes or perform selected operations such as soldering, module welding, potting, encapsulation, and radiography shall be certified on the basis of evidence of competence that includes training and testing.

b. Recertification - Contractor personnel shall be recertified if they fail to perform satisfactorily in producing products or services, if changes occur in techniques or required skills, or if their work experience as established for the process or operation is interrupted. Recertification shall require retesting of the individual to demonstrate

proficiency. Persons who fail the retest shall not perform the tasks until they receive additional training and proficiency has been demonstrated.

8.19.3 Records

Records shall be maintained of the training, testing, certification, and recertification status of personnel.

8.20 HANDLING, STORAGE, PRESERVATION, MARKING, LABELING, PACKAGING, PACKING, AND SHIPPING

The contractor shall write and implement procedures for the handling, storage, preservation, marking, labeling, packaging, packing, and shipping of all products. These procedures shall be submitted in accordance with Appendix A and shall implement the requirements of NHB 6000.1 (Appendix B) and the following pararaphs.

8.20.1 Handling

The protection of products during the life of the contract shall be achieved through the use of handling equipment and techniques that have been certified before use. Evidence of initial and periodic proof-testing of handling equipment shall be maintained.

8.20.2 Preservation, Marking, Labeling, Packaging, and Packing

Products shall be stored, preserved, marked, labeled, packaged, and packed to prevent deterioration, contamination, or damage during all phases of the program. Stored and stocked items shall be controlled in accordance with documented procedures and be subject to quality surveillance as stated in section 8.14.3.4.

8.20.3 Shipping

Prior to shipping, the contractor shall ensure that:

a. Fabrication, inspection, and test operations have been completed and accepted.

b. All products are identified and marked in accordance with requirements.

c. The accompanying documents (contractor's shipping and property accountable forms) has been reviewed for completeness, identification, and quality approvals.

d. Evidence exists that preservation and packaging requirements have been complied with.

e. Packaging and marking of products, as a minimum, comply with Interstate Commerce Commission rules and regulations and are adequate to ensure safe arrival and ready identificaton at their destinations.

f. The loading and transporting methods that are designated in the shipping docuents have been complied with.

g. Interity seals have been placed on shipping containers.

h. In the event of unscheduled removal of a product from its container, the extent of reinspection and retest shall be as authorized by SEL or its representative.

i. Special handlng instructions for receiving activities are provided where appropriate. (Amend 4 B. 6)

The contractor's quality assurance oranization shall verify prior to shipment that the above requirements have been met. QA shall sign off appropriate shipping documents to provide evidence of this verification.

8.21 GOVERNMENT PROPERTY CONTROL

8.21.1 Contractor's Responsibility

In accordance with the provisions of the contract, the contractor shall be responsible for and shall account for all property supplied by the government, including government property that may be in the possession or control of a supplier. The contractor's responsibility shall include, but not be limited to, the following:

a. On receipt, examination of products to detect damage that may have occurred in transit

b. Inspection for quantity, completeness, proper type, size, and grade as specified in the shipping documents

c. Provision for the protection, maintnance, calibration, periodic inspection, segregation, and controls necessary or prventing damage or deterioration during handling, storage, installation, or shipment

d. Maintenance of records that include

1 Identification of the property

2 Location of the property

3 Dates, types, and results of contractor inspections, tests, and other significant events

e. Any functional tests on the product that are directed by SEL.

8.21.2 Unsuitable Government Property

The property shall be processed in accordance with government procedures and section 8.12. The property shall not be dispositioned, repaired, reworked, replaced, or in any way modified unless such action is authorized by the contract or by the contracting officer in writing.

8.22 GOVERNMENT ACCEPTANCE

Before acceptance by SEL, quality assurance personnel shall ensure that deliverable contract end-items, including the Acceptance Data Package, defined in Appendix A under 8.22, are in accordance with contract requirements. A copy of the data package shall be submitted to SEL in accordance with Appendix A, and a copy shall accompany each end-item.

9. CONTAMINATION

9.1 CONTAMINATION CONTROL PLAN

The contractor shall prepare a Cleanliness and Contamination Control Plan that sets forth the requirements (including facility requirements) to prevent external and internal sources of particulate and molecular contamination of flight hardware. The plan shall include the implementing and controlling documents and the methods of measuring and maintaining the specified level of hardware cleanliness. Tests and inspections shall verify cleanliness during all phases of fabrication and assembly. The plans shall be submitted as part of the Performance Assurance Plan (section 1.3) or as a stand-alone document in accordance with Appendix C. Assurance personnel shall ensure compliance with the control plan. (Amend 4 B. 7.)

9.2 CONTAMINATION CONTROL

a. All subassembly and higher level hardware shall be produced in clean areas in accord with the control plan. Clean areas shall be controlled in accordance with FED-STD-209B A contamination-sensitive product fabricated in a clean environment shall not be opened except in an environment equal to or cleaner than the one in which the product was produced. Testing and monitoring equipment and cleaning, handling, and packaging materials shall not be sources of contamination.

b. To monitor organic contamination, witness plates (mirrors) shall be placed at strategic locations to collect residue during thermal vacuum tests. All mirrors shall removed after each new environmental exposure, and their surface residue shall be evaluated by infrared (IR) or visual techniques.

c. Bakeouts of major wiring harnesses and thermal blankets shall be required unless SEL can be shown that the contamination allowance (see NASA RP -1124 Appendix B under 6.2.1) can be met without bakeouts. (ref. 6.2.4)

d. Because they can be a source of contamination, special consideration shall be given to materials and equipment used in cleaning, handling, and packaging flight hardware. Spectroscopy grade cleaning solutions, consistent with total requirements of the payload and its components, shall be used on flight hardware.

e. If special handling, storage, or operational procedures are required for maintaining the cleanliness level at the spacecraft contractor's facility, the special requirements shall be coordinated with the spacecraft contractor before shipment of the instrument.

APPENDIX A
DELIVERABLE DOCUMENTS AND SEL RESPONSE

Referenced Section	Description	Time of Delivery	SEL Action	Number of copies
Section 1				
1.3	Performance Assurance Plan -- In addition to the data called for in the text, the following items (a through c) shall be submitted:	with proposal	I	6
1.3.1	a. Contractor's practices and procedures referenced in the plan	with proposal	I	3
1.9 & 1.9.1	b. Audit program		I	2
5.2.3	c. Contractor's derating policy		I	2
1.4	Previously designed, fabbicated, or flown hardware data			
	a. Initial	With proposal	I	2
	b. Update	At time of PDR	A	2
1.6	Performance Assurance Status Report	Monthly	I	2
Section 2				
2.2	Review Data Package	2 weeks before review meeting	I	10

A - SEL approves within the period that has been negotiated and specified in the contract before contractor may proceed.
R - SEL reviews and may comment within 30 days; contractor may continue work unless comment requires him to stop.
I - Information; the contractor's work schedule is not normally affected.

Referenced Section	Description	Time of Delivery	SEL Action	Number of copies
Section 3				
3.2.1	Verification Plan			
	a. Initial	With proposal	A	3
	b. Update	At time of PDR	A	3
3.2.1	Verification Procedures	30 days before the particular test activity for subsystem and payload levels	R	2
3.2.3	Verification Reports	30 days after completion of activity	I	2
Section 4				
4.4	Operations Hazard Analyses	30 days before an activity or use of a facility	R	2
Section 5				
5.2.2	Nonstandard Part and Device Data Package	In time for approval before procurement or use	A	3
5.2.6	Contractor DPA procedures and requirements	As generated	R	2
5.3	Part and Device Identification List	a. 90 days after award date	I	3
		b. Update 30 days before PDR	I	3
		c. Update 30 days before CDR	I	3
		d. Update 30 days after change	I	3

Referenced Section	Description	Time of Delivery	SEL Action	Number of copies
Section 6				
6.2.6	Data on cured, out-of-date materials	30 days before use of materials	A	2
6.4a	Data on nonconventional application of materials	30 days before use of materials	A	2
6.4b	Enineering drawings for material application	Upon request	I	2
6.4c, d,e,f	Material list (inorganic and polymeric), lubrication list, and process list			
	a. Preliminary	30 days before PDR	R	3
	b. Final	30 days before CDR	A	3
	c. Updates	As changes are made; between CDR and delivery	A	3
Section 7				
7.1	Reliability Program	in Performance Assurance Plan	R	3
7.3.2	Failure Mode, Effects, and Criticality Analysis			
	a. Preliminary	30 days before PDR	R	3
	b. Final	30 days before CDR	R	3
	c. Updates	With class 1 changes	R	3
7.3.3	Part and Device Stress Analyses			
	a. Preliminary	30 days before PDR	R	3
	b. Final	30 days before CDR	R	3

Referenced Section	Description	Time of Delivery	SEL Action	Number of copies
	c. Updates	With class 1 changes	R	3
7.3.5	Trend Analyses			
	a. List of parameters to be monitored	At time of CDR	I	3
	b. Trend analysis reports	At time of PER and PSR	I	3
7.4	Limited-Life List			
	a. Preliminary	30 days before PDR	R	3
	b. Final	30 days before CDR	R	3
	c. Updates	As changes are made; between CDR and delivery	R	3
Section 8				
8.10.1	Fabrication and Assembly Flow Plan			
	a. Preliminary	30 days before PDR	R	3
	b. Final	30 days before CDR	R	3
8.11	Electrostatic Discharge Control Plan			
	a. Initial	30 days before PDR	A	3
	b. Update	30 days before CDR	A	3
8.12.1.3	MRB decisions on nonconformance	As generated	I	2
8.12.1.3c(3)	Request for repair/use-as-is	As generated	A	2

Referenced Section	Description	Time of Delivery	SEL Action	Number of copies
8.12.1.3c(1)	Standard repair procedures	As generated	A	2
8.12.2.1	Malfunction/failure reporting			
	a. Notification	Orally within 24 hours	I	
	b. Written notification (MR Form)	Within 3 working days	I	3
	c. Failure analysis, proposed corrective action	Orally	I	
8.12.2.2	Malfunction/failure report closeout	Completion of required actions	A	3
8.13	Alerts	As generated	I	3
8.13	Response to alerts	10 working days after receipt of notification	R	3
8.20	Procedures for handling, etc.			
	a. Initial	30 days before CDR	R	2
	b. Update	30 days before use	R	2
8.22	Acceptance Data Package for each end-item consisting of copies of:	At time of delivery of each end-item	R	
	a. As-built configuration list in accordance with section 8.2.4			5
	b. List of parts/devices used in the hardware, prepared in accordance with section 5.3			5

Referenced Paragraph	Description	Time of Delivery	SEL Action	90-2-9 Number of copies
	c. List of materials and processes that were used in the hardware			5
	d. Listing and status of all identified life-limited items			5
	e. Copy of Test Record and Calibration Book (ref. 3.2.4), including total operating time and cycle records			5
	f. Copies of results of all comprehensive performance tests			5
	g. Critical parameter trend data			5
	h. List of open items with reasons for items being open			5
	i. Safety Compliance Data Package			5
Section 9				
9.1	Contamination Control Plan			
	a. Initial	With proposal	A	3
	b. Update	At time of CDR	A	3
Appendix E				
2.0	Instrument Exterior Surface Description	before PDR	A	4
6.0	Instrument Thermal Interface Control Drawing	18 months	A	4
7.0	Instrument Final Thermal Report and Reduced Thermal Model	32 months	A	4

APPENDIX B

APPLICABLE DOCUMENTS*

Section Number	Document Number	Title	Available from
Section 2			
2.5	S-311-98A	Guidelines for Conducting a Packaging Review	GSFC Project Office
Section 5			
5.2.1	GSFC PPL 18	GSFC Preferred Parts List	GSFC Project Office
5.2.1	MIL-STD-975G	NASA Standard elctrical, Electronic, and Electromechanical (EEE) Parts List	Source 1 or 2
5.2.2.b	S-311-200B 1 Jul 87	GSFC Specification-- Hybrid Microcircuit Requirements	GSFC Project Office
5.2.4	MIL-STD-490A	Specification Practices	Source 1 or 2
5.2.6 c	S-311-70	GSFC Specification-- Construction Analysis of Electronic Parts	GSFC Project Office
Section 6			
6.2.1	None	GSFC Materials Tips for Spacecraft Applications	GSFC Project Office
6.2.1	TM 82275* (GSFC Mtr. No. 755-013)	Quality Features of Spacecraft Ball-Bearing Systems	Source 3
6.2.1	TM 82276* (GSFC Mtr. No. 313-003)	An Evaluation of Liquid and Grease Lubricants for Spacecraft Applications	Source 3

*When preparing the project's performance assurance requirement document, the representatve of the Office of Flight Assurance will insert the current revision dates.

Section Number	Document Number	Title	Available from
6.2.1	N-75-24848* (SP-3094)	Spacecraft Materials Guide	Source 3
6.2.1	NASA RP 1124	Outassing Data for Selecting Spacecraft Materials	Source 3
6.2.1	MSFC-SPEC-522A	Design Criteria for Controlling Stress Corrosion	Source 4
6.2.4	ASTM E595-77	Standard Test Method for Total Mass Loss and Collected Volatile Condensable Material from Outgas in a Vacuum Environment	Source 5
Section 8			
8.1	GSFC S-480-17	Meteorological Satellite (METSAT) Project Configuration Management Plan	GSFC Project Office
8.2.1	DOD-STD-480A Notice 1	Configuration Control - Engineering Changes, Deviations & Waivers	Source 2
8.2.2	GSFC-480-39A	METSAT Configuration Change Request	GSFC Project Office
8.10.3	NHB 5300.4 (3A-1)	Requirements for Soldered Electrical Connectors	Source 1
8.11	PD 625-263, Rev. A	Galileo Electrostatic Control for Assembly and Test Area	GSFC Project Office
8.15.1	MIL-C-45662 Notice 3	Calibration System Requirements	Source 2
8.17	MIL-STD-105D Notice 2	Sampling Procedures and Tables for Inspection by Attribute	Source 2

*NTIS (Note 3) Accession Numbers: Documents can be ordered individually from NTIS by these numbers.

Section Number	Document Number	Title	Available from
8.20	NHB 6000.1C	Requirements for Packaging, Handling, and Transportation	Source 1
Section 9			
9.2	FED-STD-209B Amendment 1	Clean Room and Work Station Requirements, Controlled Environment	Source 2

Sources:

1. Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.
2. Department of the Navy, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120-5099.
3. National Technical Information Service, Springfield, VA 22161.
4. NASA/George C. Marshall Space Flight Center, Marshall Documentation, Huntsville, AL 35812.
5. ASTM
   1916 Race Street
   Philadelphia, PA 19103.

Appendix C

Definitions and Glossary

Acceptance -- 1. The process which demonstrates that hardware is acceptable for flight. It also serves as a quality control screen for detecting deficiencies. It is less severe than qualification. 2. As in section 8.24, to receive for transfer of title. see receiving test.

Article -- an element

Assembly -- A functional subdivision of a component, consisting of parts or subassemblies that perform functions necessary for the operation of the component as a whole (e.g., power amplifier, gyroscope).

Audit -- A review of the contractor's or subcontractor's documents or hardware to verify that it complies with project requirements.

ASTM -- American Society for Testing and Materials

ATN -- Advanced Tiros-N

Catastrophic failure -- failure that prevents the achievement of mission success.

COC -- certificate of compliance

Collected Volatile Condensable Material (CVCM) -- The quantity of outgassed matter from a test specimen that condenses on a collector maintained at a specific constant temperature for a specified time. CVCM is expressed as a percentage of the initial specimen mass.

Component -- A functional subdivision of an instrument and generally a self-contained combination of items performing a function necessary for the instrument's operation (e.g., transmitter, gyro package, actuator, motor, battery).

Comprehensive Performance Test (CPT) -- a complete test of an instrument in one, stated environment. see 3.3.2.1 a.

Configuration -- The functional and physical characteristics of parts, assemblies, equipment of a system, or any combination of these that are capable of fulfilling the fit, form, and functional requirements defined by performance specifications and engineering drawings.

Configuration control -- The systematic evaluation, coordination, and formal approval/disapproval of proposed changes and implementation of all approved changes to the design and production of an item, the configuratin of which has been formally approved by the contractor, by the purchaser, or both.

Configuration item -- An element or any matter subject to configuration control.

Configuration management -- The management of configuration control; the systematic control and evaluation of all changes to baseline documents and subsequent changes to those documents that define the original scope of effort to be accomplished (contract and refernce documents) and the systematic control, identification, status accounting, and verification of all configuration items.

Contaminant -- A material, at either a molecular or a particulate level, whose presence degrades mission performance.

CPT -- Comprehensive performance test

Critical failure -- failure that significantly degrades the achievement of mission success.

CVCM -- collected volatile condensable material

Derating -- The reduction of the rating of a device to improve reliability or to permit operation at high temperature.

Design Specification -- Generic designation for a specification that describes functional and physical requirements for an item, usually at the assembly level or higher levels of assembly. In its initial form, the design specification is a statement of functional requirements with only general coverage of physical and test requirements. The design specification evolves through the project life to reflect progressive refinements in performance, design, configuration, and test requirements. In many projects, the end-item specifications serve all the purposes of design specifications for the contract end-items. Design specifications provide the basis for technical and engineering management control.

Designated Representative -- An individual (such as a NASA plant representative), firm (such as assesment contractor), Department of Defense (DOD) plant representative, or other government representative designated and authorized by NASA to perform a specific function for NASA. As related to the contractor's effort, this function may include evaluation, assessment, design review participation, and review/approval of certain documents or actions.

Destructive Physical Analysis (DPA) -- An internal destructive examination of a finished part or device to assess design, workmanship, assembly, and any other processing associated with fabrication of the part.

Discrepancy -- see nonconformance.

DPA -- destructive physical analysis

ECN -- Engineering Change Notice

EDC -- electrostatic discharge control

EEE -- electrical, electronic and electromechanical

Electromagnetic Compatibility -- The condition that prevails when various electronic devices are performing their functions according to design in a common electromagnetic environment.

Electromagnetic Interference (EMI) -- Electromagnetic energy that interrupts, obstructs, or otherwise degrades or limits the effective performance of electrical equipment.

Electromagnetic Susceptibility -- Undesired response by a component or instrument to conducted or radiated electromagnetic emmissions.

Element -- Any of the levels of assembly. An item. An element is made of elements below it in this list:

Payload		
Subsystem	=	instrument
Component		
Assembly		
Subassembly		
Part		

ELV -- expendable launch vehicle.

EMC -- electromagnetic compatability

End-item -- a deliverable element

ESD -- electrostatic discharge

Failure -- see nonconformance.

Failure Modes, Effects, and Criticality Analysis (FMECA) -- Study of a system and working interrelationships of its elements to determine ways in which failures can occur (failure modes), the effects of each potential failure on the system element in which it occurs and on other system elements, and the probable overall consequences (criticality) of each failure mode on the success of the system's mission. Criticalities are usually assigned by categories, each category being defined in terms of a specified degree of loss of mission objectives or degradation of crew safety.

FRB -- failure review board

Functional Tests -- The operation of an element in accordance with a defined operational procedure to determine whether performance is within specified requirements.

GFP -- government furnished property

GIDEP -- Government-Industry Data Exchange Program

GIIS -- General Instrument Interface Specification

GSI -- government source inspection

Hardware -- hardware is composed of elements. As used in this document, there are two major categories of hardware as follows:

1. Prototype Hardware -- Hardware of a new design; it is subject to a design qualification test program; it is not intended for flight.

2. Flight Hardware -- Hardware to be used operationally in space. It includes the following subsets:

   a. Protoflight Hardware -- Flight hardware of a new design; it is subject to a design qualification test program.

   b. Follow-on Hardware -- Flight hardware built in accordance with a design that has been qualified either as prototype or as protoflight hardware; follow-on hardware is subject to a flight acceptance test program.

   c. Spare Hardware -- Hardware whose design has been proved in a design qualification test program; it is subject to a flight acceptance test program and is used to replace flight hardware that is no longer acceptable for flight.

IAC -- independent assurance contractor

Inspection -- The process of measuring, gaging, or otherwise compari[illegible] an article or service with specified requirements.

Instrument -- A subsystem consisting of sensors add material for making measurements or observations in space.

Integration -- the putting together of elements a[illegible] next higher level of assembly, especially above the as[illegible]t

Item -- an element; any subject of configuration c

JANTX -- joint army navy diode or transistor grade MIL-S-19500

JANTXV -- joint army navy diode or transistor grade 2

Level -- a step in the heirachy of hardware elements; an intensity or magnitude

Limited performance test -- a test, less complete than a comprehensive performance test; a liveness test. see 3.3.2.2

Margin -- The amount by which hardware capability exceeds requirements.

Mission Allowable Temperatures -- The mission allowable temperature limits encompass those temperatures experienced during the mission.

Monitor -- To keep track of the progress of a performance assurance activity; a person who monitors. The monitor need not be present at the scene during the entire course of the activity, but he will review resulting data or other associated documents. see witness.

MRB -- material review board

NDE -- nondestructive evaluation see 8.9

Nonconformance -- A condition of any hardware, software, material, or service in which one or more characteristics do not conform to requirements. As applied in quality assurance, nonconformances fall into two categories:

1. Discrepancy -- A departure from specification that is detected during inspection or process control testing, etc., while the hardware or software is not functioning or operating.

2. Failure -- A departure from specification that is discovered in the functioning or operation of the hardware or software.

Nonstandard EEE part -- see section 5.2.2

NSPL -- NASA Standard (EEE) Parts List which is MIL-STD-975

OHA -- operations hazard analysis

Part -- A hardware element that is not normally subject to further subdivision or disassembly without destruction of designed use.

Payload -- An integrated assemblage of subsystems designed to perform a specified mission in space.

Performance Verification -- Determination by test, analysis, or a combination of the two that the instrument can operate as intended in a particular mission; this verification includes ensuring that the design has been qualified and accepted as true to the design and ready for spacecraft integration.

PPL -- preferred parts list

Product -- an element

Prototype hardware -- see Hardware

Qualification -- The process which demonstrates that a given design and manufacturing approach will produce hardware that will meet all performance specifications when subjected to defined conditions more severe than those expected to occur during its intended use. It is more severe than acceptance.

QA -- quality assurance

Qualified hardware -- Hardware the design and manufacturing of which has been successfully through qualification.

Receiving test -- a test by the government, often similar to an acceptance test, used on delivery to determine to accept transfer of title; such a test by anyone. see acceptance 2.

Redundancy (of design) -- The use of more than one independent means of accomplishing a given function.

Repair -- restore to the design.

Rework -- Return for completion of operations (complete to drawing); reprocess to conform to the specification or drawing; change to conform to a design change.

RH -- relative humidity

Similarity, Verification by -- A procedure of comparing an item with a similar one that has been verified. Configuration, test data, application, and environment should be evaluated. It should be determined that design differences are insignificant, that environmental stress will not be greater in the new application, and that manufacturer and manufacturing methods are the same.

Single-Point Failure -- The failure of a single element of hardware, which results in loss of mission objectives, hardware, or crew, as defined for the specific application or project for which a single-point failure analysis is performed.

SSIP -- System Safety Implementation Plan

Standard part -- see section 5.2.1

STS -- Space Transportation System, "shuttle"

Subassembly -- A subdivision of an assembly (e.g., wire harness, loaded printed-circuit board).

Subsystem -- A functional subdivision of a payload consisting of two or more components (e.g., attitude control, electrical power, communications subsystem, an instrument).

Thermal Balance Test -- A test conducted to verify the adequacy of the thermal design and the capability of the thermal control system to maintain thermal conditions within established mission limits.

TML -- total mass loss

Total Mass Loss (TML) -- Total mass of material outgassed from a specimen that is maintained at a specified constant temperature and operating pressure for a specified time. TML is expressed as a percentage of the initial specimen mass.

UIIS -- Unique instrument interface specification

Verification -- A general word meaning to verify, demonstrate or show by record, as outlined in section 3.1, that a requirement is met; both qualification and acceptance are performance verifications.

Vibroacoustics -- An environment induced by high-intensity acoustic noise associated with various segments of the flight profile; it manifests itself throughout a payload in the form of directly transmitted acoustic excitation and as structure-borne random transmitted excitation.

Witness -- A personal on-the-scene observation of a performance assurance activity with the purpose of verifying compliance with project requirements. see Monitor.

APPENDIX D

SEM Environmental Specification

1.0 Qualification

The Engineering Model and the Protoflight Model shall be subjected to the following qualification environmental tests. The instrument shall be operated during these tests in a manner simulating actual operation during the various flight stages. For test and analysis the axes are defined as:

Z-Z: Thrust axis, as applicable to unit installed on the spacecraft in launch configuration.

X-X & Y-Y Perpendicular to Z-Z and defined as the spacecraft X-X and Y-Y axes.

1.1 Design Criteria (Static Load) (Deleted)

1.2 Acceleration Qualification (Static Load)

A test shall be conducted where a 15.5 g is applied successively to each of three orthogonal axes. The test may use either static load, centrifuge or sine burst. If the test is static load or centrifuge the duration for each of the three axes shall be 30 seconds. If the test is sine burst, it shall be done according to paragraph 1.2.1.

1.2.1 Sine Burst

The sine burst test is used to simulate a static load on the test item. The test is performed on a vibration shaker. The frequency used to perform the test is a function of both the dynamic characteristics of the test item and the vibration shaker facility limitations. Because the test is intended to impart a static load to the test item, the test frerquency must be below the fundamental resonant frequency of the test item. As a general guideline, the test frequency should be less than one-third the lowest test item resonant frequency to avoid dynamic amplification during the test. The vibration shaker facility limitation is driven by the maximum allowable displacement for the particular shaker.

Figure D-0 shows a typical sine burst waveform. The waveform is sinusoidal with a ramp up to maximum level, several cycles at maximum level, and then ramp down to zero. The number of cycles at maximum level is usually 6 to 10 cycles. The specification of a sine burst test should contain the following information:

1. Test Level = $\pm$ XX.X g
2. Test frequency = less than 1/3 the lowest resonant frequency of the test item
3. Test Duration = 6 to 10 cycles at maximum level.

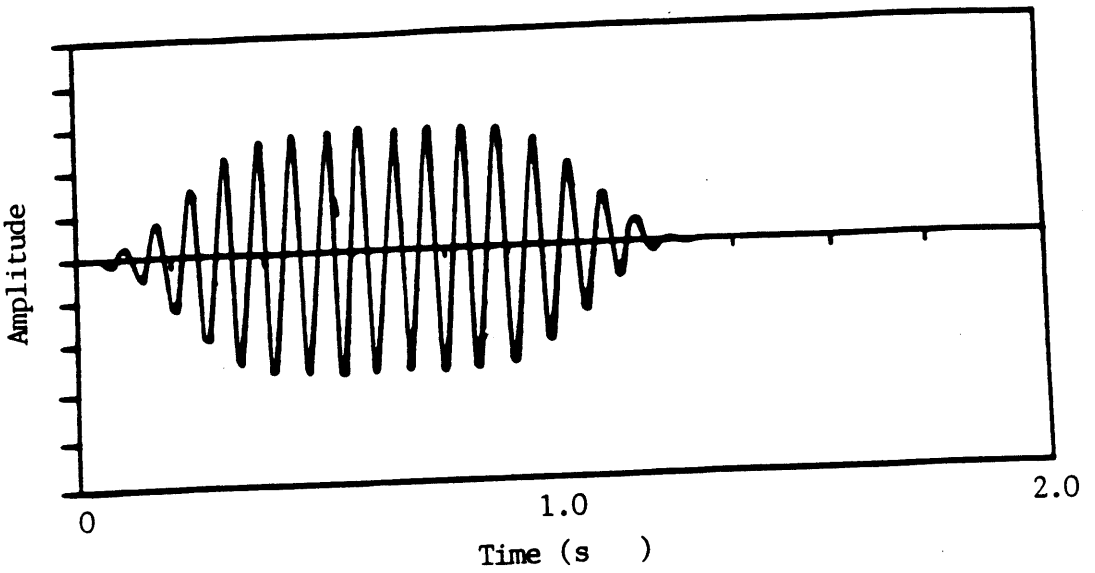


Figure D-0

1.3 Random Vibration Qualification 89-12-18

The instrument shall be subjected to the following qualification level random vibration in each of three orthogonal axes:

Freq. range Hz	Power spectral density g^2/Hz	g rms	Duration
20-75	0.011		
75-150	+10 dB/oct.	8.8	1 min/axis
150-500	0.11		
500-2000	-7 dB/oct.		

1.4 Shock Qualification

The shock spectrum, pulse, or complex transient, as shown in Fig D-1, shall be applied once along the three major axes of the test items.

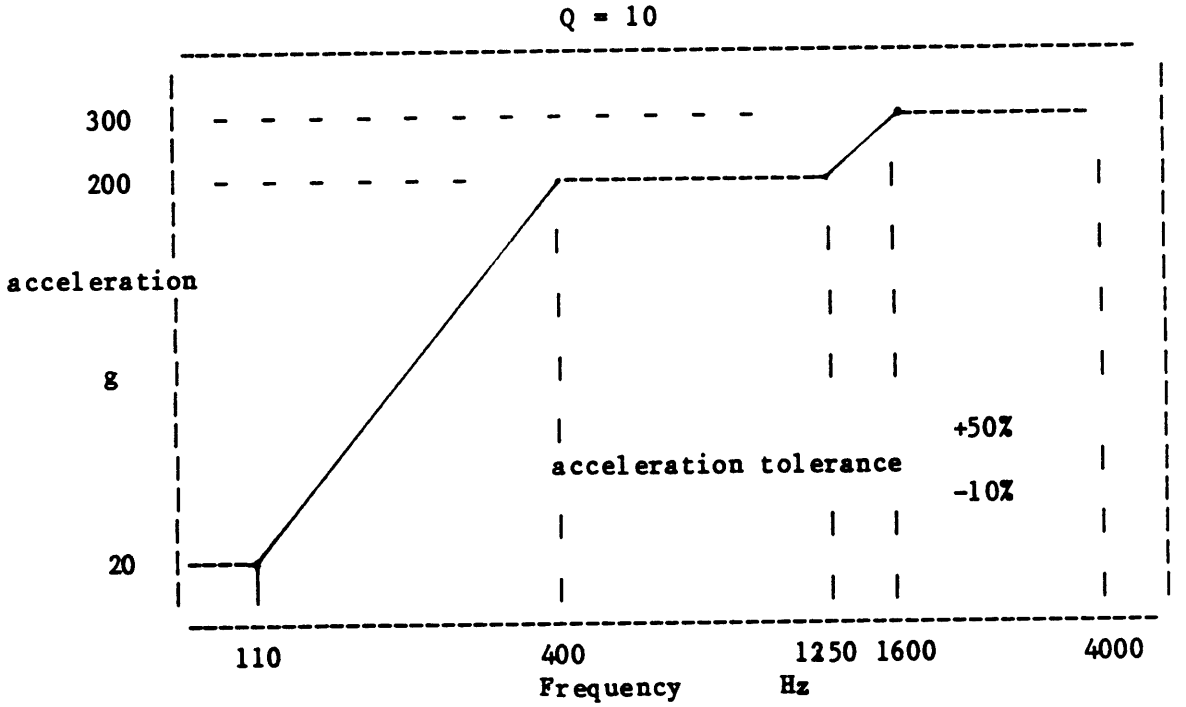


Figure D-1 Spectrum for Shock Qualification

1.5 Launch Phase Pressure Profile

The instrument shall be designed such that, when subjected to the environment in Figure D-2, no adverse conditions which may effect performance shall result. An actual qualification test is required if analysis does not indicate a sufficient margin of safety.

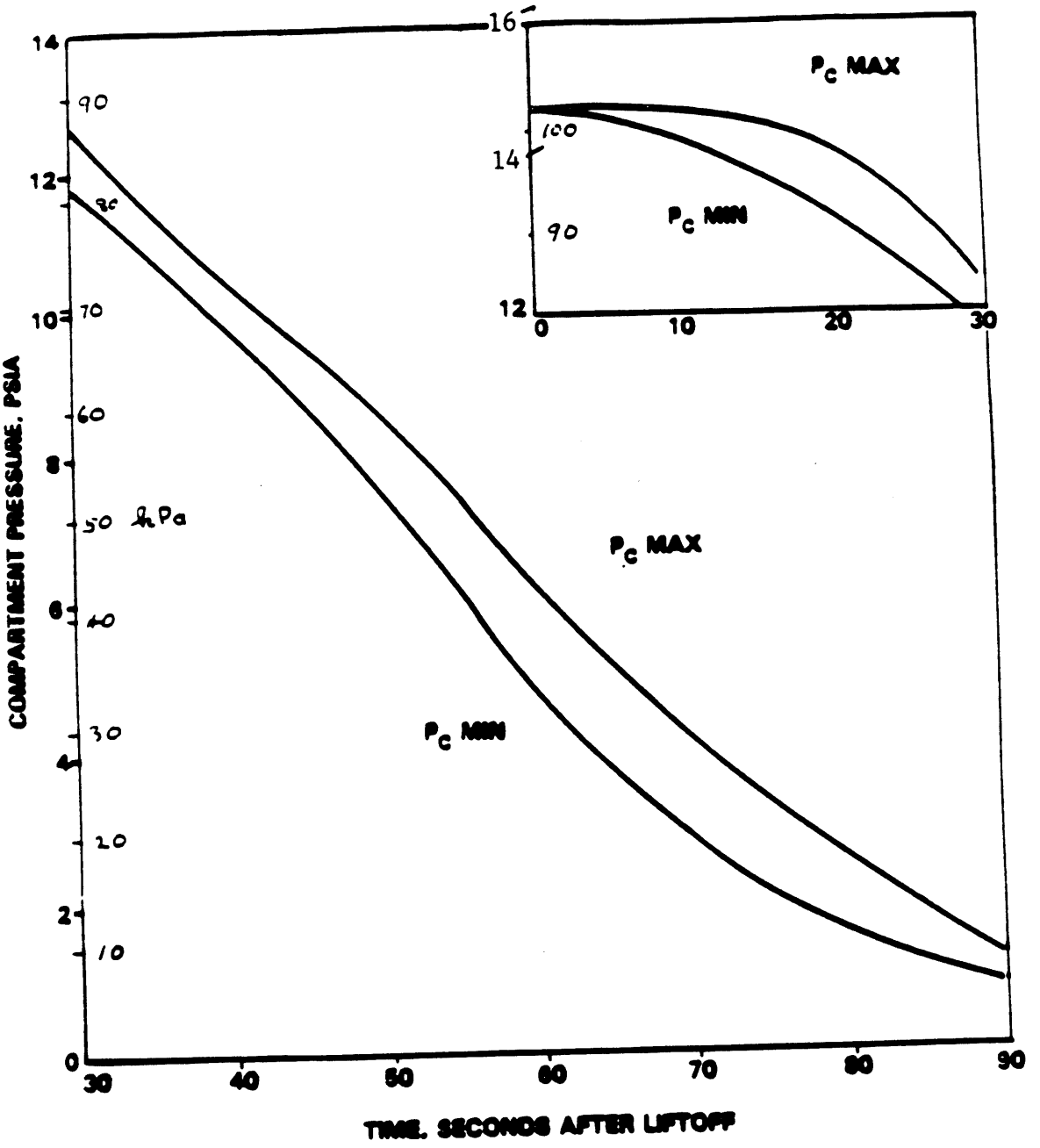


Figure D-2. Launch Phase Pressure Profile

1.6 Acoustic Qualification

The spacecraft with its payload, as part of its environmental testing sequence, will be exposed to the acoustic levels shown in Table 1. During launch, a similar environment is expected inside the shroud.

The specified instrument random vibration levels are based upon the above acoustic levels, which are coupled with and conducted through the spacecraft structure and finally mechanically transmitted to the instruments.

However, the contractor shall review his instrument for large area/low mass components which would be exposed to and could be effected by direct acoustic energy. Such instruments may require an acoustic test to assure proper operation during and subsequent to the launch phase.

TABLE 1
LAUNCH ACOUSTIC LEVEL (INTERNAL)

1/3 Octave Band Center Frequency Hz	1/3 Octave Band Sound Pressure Level dB	
	Qualification	Acceptance
40	120.5	117.5
50	123	120
63	125	122
80	126.5	123.5
100	128.2	125.2
125	130	127
160	131.5	128.5
200	133	130
250	133.8	130.8
315	134.5	131.5
400	134.75	131.75
500	134	131
630	133	130
800	130.5	127.5
1000	128	125
1250	125.5	122.5
1600	122.5	119.5
2000	119	116
2500	116	113
3150	113	110
4000	109	106
5000	106	103
6300	102	99
8000	98	95
10000	95	92
Overall SPL	142.5	139.5
Test Duration	1.0 minute	1.0 minute

SPL Reference - 0.0002 dynes/cm^2 = 2 x 10^{-5} N/m^2 rms

1.7 Thermal Vacuum Qualification

The instrument shall be subjected to a thermal vacuum test in which the pressure is less than 0.00133 Pa (1×10^{-5} torr) and the test temperature profile is as shown in Figure D-3. The unit shall be in the launch phase mode for pump down and in the mission mode for all other phases of this test. The temperature extremes shall be 10 °C more severe than the mission allowable temperatures. During temperature transitions the rate of change in temperature shall not exceed 10 °C/hour or be less than 5 °C/hour.

Thermal instrumentation shall be attached to the unit in sufficient number and location to measure the maximum and minimum structural temperatures as well as critical items and those required for calibration. Control of the test for conformance to the specification shall be based on the temperature of the base plate. This instrumentation shall not invalidate the thermal environment being measured.

In planning and conducting the test, care shall be exercised so that unrealistic internal gradients are not generated which could jeopardize the integrity of the instrument.

1.8 Electromagnetic Interference Qualification

An EMI test shall be performed in accordance with the levels specified in the General Instrument Interface Specification, 3.6.

2.0 Acceptance

Flight Models (does not include the Protoflight Model) shall be subjected to the following acceptance environmental tests.

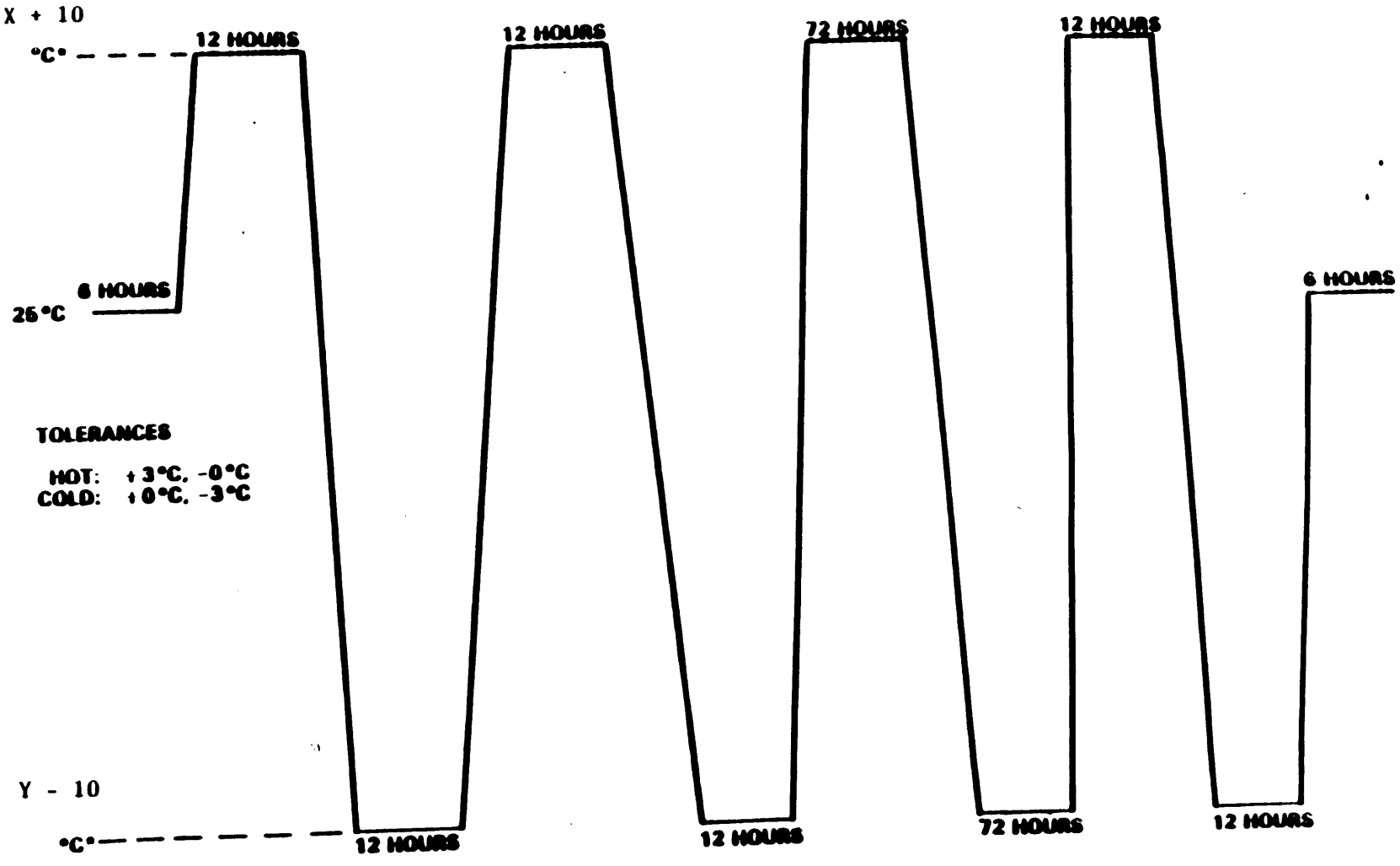
2.1 Random Vibration Acceptance

The instrument shall be subjected to the following acceptance level random vibration in each of three orthogonal axes.

Freq. Range Hz	Power spectral Density g^2/Hz	g rms	Duration
20-75	0.008		
75-150	+10 dB/oct.	7.52	1 min/axis
150-500	0.08		
500-2000	-7 dB/oct.		

2.1.2 Acceleration Test (Static Load)

A test shall be conducted the same as in 1.2 except that the load shall be 12.4 g rather than 15.5 g.



*TBD

Figure D-3. Design Qualification T/V Profile

2.2 Shock Acceptance

The shock spectrum, pulse, or complex transient, as shown in Figure D-4, shall be applied once along the three major axes of the test items.

2.3 Thermal Vacuum Acceptance

Flight Models shall be subjected to a thermal vacuum test in which the pressure is less than 0.00133 Pa (1×10^{-5} torr) and the test profile is as shown in Figure D-5. The unit shall be operational for all phases of this test. The temperature extremes shall be the mission allowable temperatures. During the test, the hottest and coldest parts of the instrument structure shall be driven to the temperatures determined to be appropriate based on the requirements stated above.

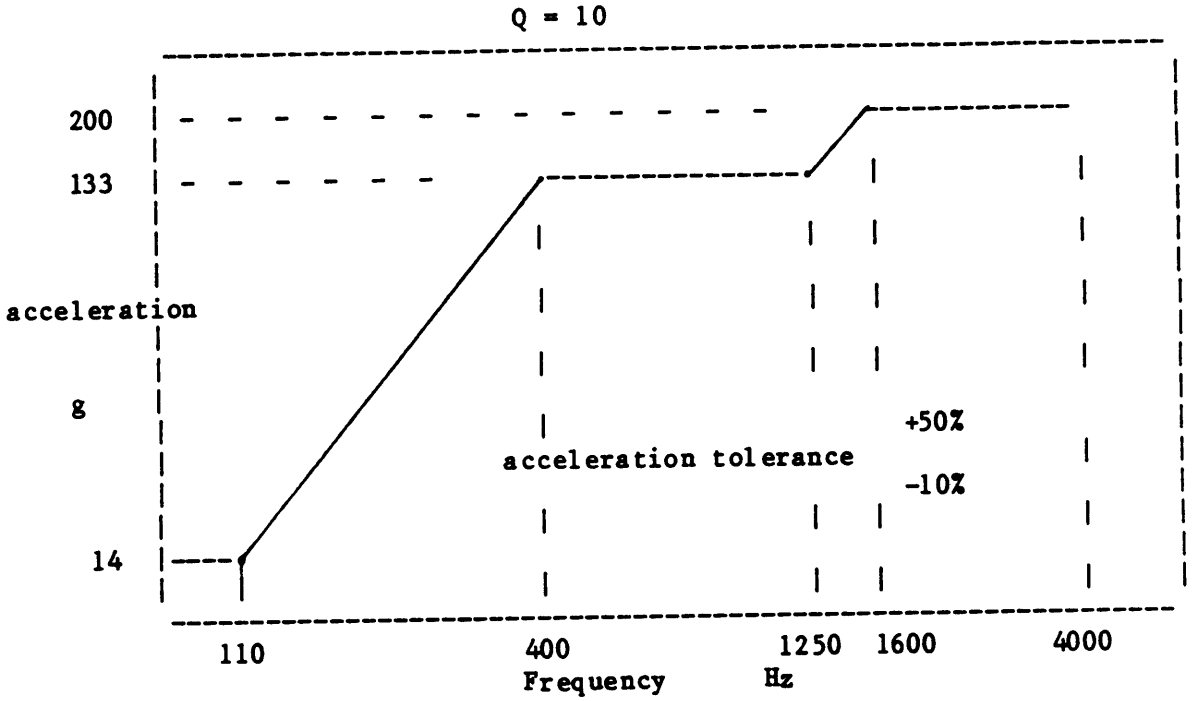


Figure D-4 Spectrum for Shock Acceptance

Thermal instrumentation shall be attached to the unit in sufficient number and location to measure the maximum and minimum structural temperatures as well as critical items and those required for calibration (e.g., A/D, etc). Control of the test for conformance to the specifications shall be based on the temperature of the base plate. This instrumentation shall not invalidate the thermal environment being measured.

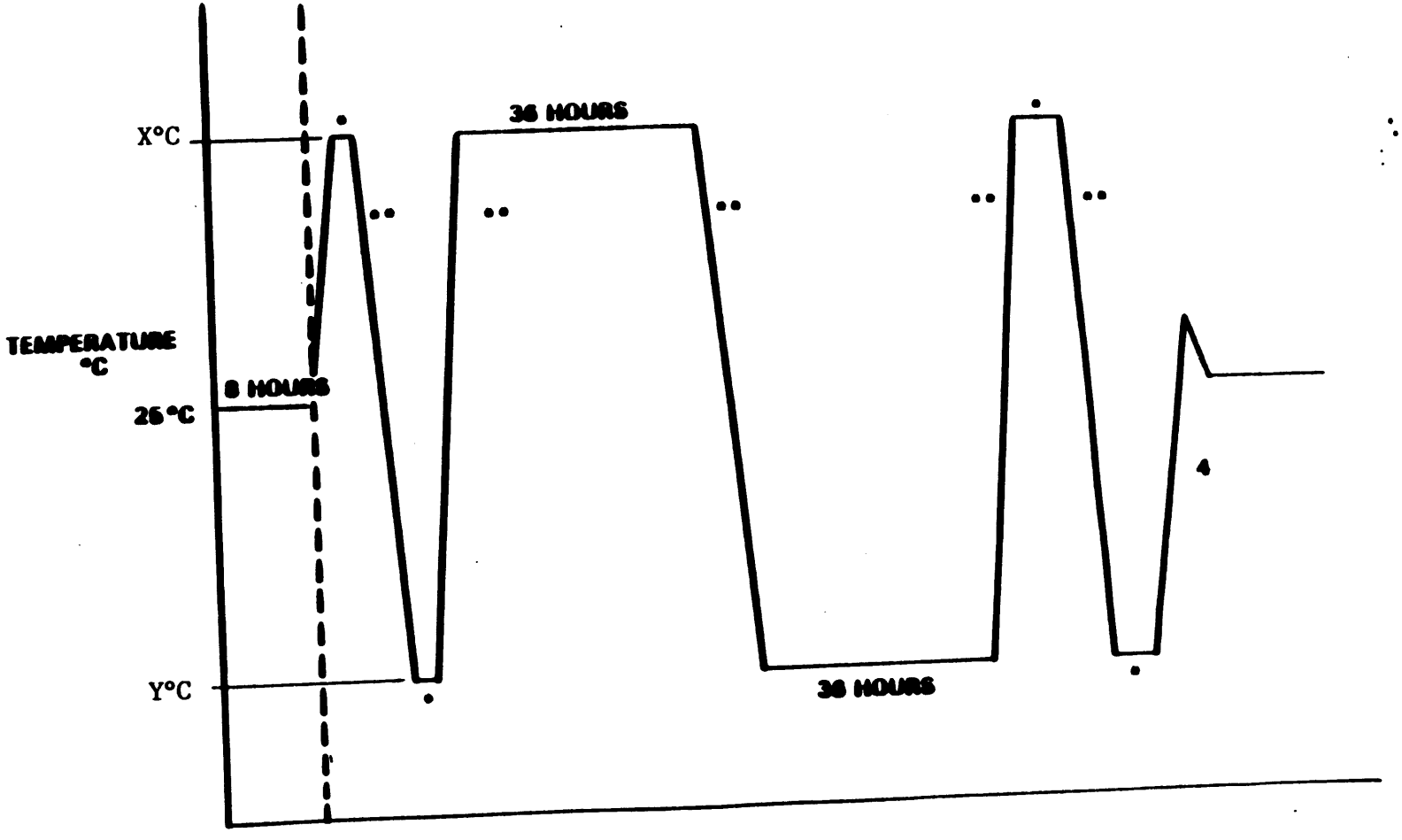


Figure D-5 Flight Model Acceptance Thermal Vacuum Test

In planning and conducting the test, care shall be exercised so that unrealistic internal gradients are not generated which could jeopardize the integrity of the instrument.

2.4 Electromagnetic Interference Acceptance

There is no EMI acceptance test. However, the SEM shall meet the requirements of GIIS 3.6. The SEM contractor shall, if requested, assist and make repairs as necessary to meet the EMI requirements as shown by test with cables attached at the spacecraft contractor's plant.

Appendix E

Details of Tiros Thermal Interface Requirements

REQUIRED ITEMS

1. Spacecraft Thermal Interface Control Drawing

This drawing will be provided by the spacecraft contractor. It will be a controlled drawing that will be ECN'd as changes affecting the configuration occur.

1.1 A complete ATN orbital configuration will be shown, including all instruments, antennas, and the deployed solar array.

1.2 This drawing will be scalable, with reference dimensions.

1.3 A table will be included listing all spacecraft materials and coatings thermal properties, including variations. Effective emittances or conductances of blankets will be noted. The exterior surface thickness will be included for 2nd surface films.

1.4 All external surface materials and coatings will be labeled on the drawing.

1.5 The drawing will show the spacecraft coordinates.

1.6 The drawing will include views of the spacecraft from the +X, +Y, and -Y directions. It will also include cross section views toward +Z at the ESM/TRUSS interface, and toward -Z at the ESM/IMP intertace.

1.7 The deployed solar array will be shown projected in the view toward +Z, with the maximum circle of rotation illustrated.

2.0 Instrument Exterior Surface Description

The instrument contractor shall provide this information which will be used by the spacecraft contractor to generate the environmental heat flux inputs and the radiation couplings for a given instrument.

2.1 This information shall include exterior surface drawings and/or sketches of the instrument, denoting each external surface that is to be considered a separate node by a different number.

2.2 The total number of nodes shall be less than 30 per instrument.

2.3 The dimensions of each node shall be shown.

2.4 The ATN spacecraft coordinate system shall be shown in the drawings. Any origin for the coordinate system can be assumed, but the origin assumed must be illustrated.

2.5 A table shall be included which lists the following information for each node:

a. node number,

b. the coordinates for each vertex of a node (a given node can have any number of vertexes but all node surfaces must be outlined by straight lines),

c. the node surface nominal absorptances and emittances,

d. node area.

2.6 For instruments with exterior surfaces which change position relative to the spacecraft in orbit, scanners for example, separate nodes will have to designated for the different positions. Additional sketches shall be provided showing the alternate positions for which fluxes are to be calculated.

3.0 Orbital Heat Flux and Radiation Coupling Report

This report will be prepared by the spacecraft contractor. It will define the spacecraft and instrument surfaces considered, referenced to the ATN spacecraft coordinates. The format will be the same as presented in RCA Report No. TH-154.

3.1 The report will list fluxes and couplings for all the nodes designated in section 2.0 above, and for all other instrument and spacecraft surfaces which significantly shadow or view the instrument in question.

3.2 Separate tabulations of fluxes versus time and orbital average values will be provided for: Direct solar, indirect solar, direct albedo, an total solar plus albedo fluxes. Indirect solar fluxes will be diffusely reflected solar fluxes. All fluxes will be incident fluxes.

3.3 Orbital average, incident, Earth IR, fluxes will be tabulated.

3.4 Fluxes will be tabulated for gamma angles of 0, 15, 28, 45, 68 and 80 degrees. Gamma angle is the half angle of the cone the solar vector traces around the spacecraft +Z axis, over one orbit.

3.5 "Script F" view factors for all the surfaces considered will be provided as part of the report.

3.6 View factors to space for all surfaces will be tabulated.

4.0 Adjacent Surface Temperatures

The instrument contractor will be provided with tabulations of spacecraft and other instrument orbital temperatures versus time, for those surfaces for which the data have already been generated. For the remaining surfaces seen by the instrument in question the following data will be provided:

a. the maximum and minimum internal temperature and the gamma angle for which that extreme occurs,

b. the surface blanket through-conductance or effective emittance,

c. the surface absorptance and emittance,

d. the heat flux and radiation coupling data provided in the report of paragraph 3.0 above.

5.0 Launch and Orbital Acquisition Requirements

The instrument contractor will be provided with shroud, aerodynamic and orbital acquisition, environmental heat inputs.

6.0 Instrument Thermal Interface Control Drawing

The instrument contractor shall provide this drawing which shall include the following features:

6.1 It must be scalable with reference dimensions and show orientations of the surfaces relative to the ATN spacecraft coordinates.

6.2 All external coatings and materials shall be labeled. A table of the thermal properties and variations assumed for the external surfaces shall be included. Effective emittances or conductances through blankets must be noted. The thicknesses of outer layer 2nd surface coatings shall be indicated.

6.3 A view of all faces of the instrument shall be shown. Surface configuration variations (for example, different scanner positions) shall be shown, if applicable.

6.4 Details of the mounting interface shall be shown such as:

a. Number and dimensions of mounting feet or surfaces in contact with the spacecraft,

b. Materials and dimensions of isolators,

c. Conductances assumed.

6.5 Significant structural materials used shall be noted.

6.6 The locations and amounts of power dissipated shall be indicated. A power summary or profile shall be included which gives power variations for all modes of operation.

6.7 All heater locations and powers shall be indicated.

6.8 All thermistor locations shall be noted. A "control" or reference thermistor shall be specified for which temperature limits as defined in the UIIS (when written) are applicable.

6.9 The drawing shall illustrate how the instrument thermal blankets will interface with the spacecraft structure or spacecraft thermal blankets.

7.0 Instrument Final Thermal Report and Reduced Thermal Model

The instrument contractor shall provide this report and model. The requirements for both are listed below.

7.1 The report shall describe the instrument final thermal design.

7.2 The report shall provide transient and orbital average temperature predictions and heater powers required for:

a. the worst hot and cold orbital conditions for normal operating modes,

b. special high power modes of operation in orbit, if thermally significant,

c. orbital conditions with instrument off,

d. launch and orbital acquisition,

e. temperature predictions and heating and cooling requirements for the instrument during spacecraft Integration and Testing.

- - - - - - - - - - - -

VERIFICATION TEST REPORT

PROJECT _____

TEST ITEM _____

MANUFACTURER _____

SERIAL NUMBER _____

LEVEL OF ASSEMBLY: |__| COMPONENT |__| SUBSYSTEM |__| PAYLOAD

TYPE HARDWARE: |__| PROTOTYPE |__| PROTOFLIGHT |__| FLIGHT |__| SPARE

TYPE TEST:

|__| STRUCTURAL LOADS
|__| VIBRATION
|__| ACOUSTICS
|__| MECHANICAL SHOCK
|__| MECHANICAL FUNCTION
|__| MODAL SURVEY
|__| PRESSURE PROFILE
|__| MASS PROPERTIES
|__| ELECTROMAGNETIC COMPATIBILITY
|__| MAGNETIC PROPERTIES
|__| THERMAL-VACUUM
|__| THERMAL BALANCE
|__| THERMAL CYCLING
|__| TEMPERATURE-HUMIDITY
|__| LEAKAGE
|__| COMPREHENSIVE PERFORMANC

|__| OTHER (explain) _____

VERIFICATION PROCEDURE NO. _____ REV. _____ DATE _____

|__| INITIAL TEST

|__| RETEST (|__| PARTIAL OR |__| FULL; STARTING DATE OF INITIAL TEST _____

APPLICABLE VERIFICATION PLAN: _____

FACILITY DESCRIPTION: _____

LOCATION: _____

TEST LOG REFERENCE: _____

COMMENTS:

SIGNATURE:

QUALITY ASSURANCE REPRESENTATIVE: _____ DATE _____

COGNIZANT ENGINEER FOR TEST ITEM: _____ DATE _____

NASA

NONSTANDARD PART APPROVAL REQUEST

(See Instructions on Back)

GSFC

1. CONTRACT NUMBER NAS5-	2a. NSPAR NUMBER
3. PROJECT NAME	2b. RESUBMITTAL ☐
4a. CONTRACTOR	
4b. SUBCONTRACTOR	
5. SYSTEM & COMPONENT	
6. PART NAME	7. PART GRADE ☐1 ☐2
8. PART NUMBER	9. COMMERCIAL PART NUMBER
10. MANUFACTURER	FSCM-
11. PROCUREMENT SPEC.	REVISION
12. SCREENING SPEC.	REVISION

13. RATIONALE FOR USE OF NONSTANDARD PART: _____

14. BASIS FOR ACCEPTANCE: _____

15. CONTRACTOR CERTIFICATION

PREPARED BY: _____ *Title* _____ *Date*

APPROVED BY: _____ *Title* _____ *Date*

APPROVED BY: _____ *Title* _____ *Date*

GSFC 4-15 Revised (1/83) Previous Editions Obsolete

Part, Device Identification List

SUBMITTED BY _____ ☐ ADD ☐ DELETE ☐ CHANGE DATE _____

CHECK ONLY ONE

PROJECT _____ (56 57 58)

REV DATE ☐☐☐☐☐☐ (Y Y M M D D) (59–64) REV LTR ☐ (65)

SYS/INST _____ (66 68)

COMPONENT ☐☐☐☐☐☐☐☐☐☐☐☐ (69–80)

PAGE ___ of ___ PAGES

ID. NO. (1–6)	PART NAME (7–8)		MANUFACTURER (9–12)	PART NUMBER (13–29)	GRP NO (30–35)	SPECIFICATION (36–51)	QTY (52–54)	ST (55)

(2/82) SHADED AREAS ARE FOR DATA GROUP USE ONLY.

(See Instructions on reverse side)

R: 5-22-85

GSFC SPACECRAFT INORGANIC[1] MATERIALS LIST

SPACECRAFT _____ SYSTEM/EXPERIMENT _____ GSFC T/O _____

CONTRACTOR _____ ADDRESS _____

PREPARED BY _____ PHONE _____ DATE PREPARED _____

GSFC MATERIALS EVALUATOR _____ PHONE _____ DATE RECEIVED _____ DATE EVALUATED _____

ITEM NO	MATERIAL IDENTIFICATION[2]	CONDITION[3]	APPLICATION[4]	EXPECTED ENVIRONMENT[5]	GSFC EVALUATION[6]		
					A	NA	SA

GSFC 18-59A 3/78

See reverse side for notes.

GSFC SPACECRAFT POLYMERIC[1] MATERIALS LIST

SPACECRAFT _____ SYSTEM/EXPERIMENT _____ GSFC T/O _____

CONTRACTOR _____ ADDRESS _____

PREPARED BY _____ PHONE _____ DATE PREPARED _____

GSFC MATERIALS EVALUATOR _____ PHONE _____ DATE RECEIVED _____ DATE EVALUATED _____

AMOUNT CODE		
Area, cm^2	Vol., cc	Wt., gm
1. 0-1	A. 0-1	a 0-1
2. 2-100	B. 2-50	b 2-50
3. 101-1000	C. 51-500	c 51-500
4. >1000	D. >500	d >500

ITEM NO.	MATERIAL IDENTIFICATION[2]	MIX FORMULA[3]	CURE[4]	AMOUNT CODE	EXPECTED ENVIRONMENT[5]	REASON FOR SELECTION[6]	GSFC EVALUATION[7]		
							A	NA	SA

See next page for notes

GSFC SPACECRAFT LUBRICATION LIST

SPACECRAFT _____ SYSTEM/EXPERIMENT _____ GSFC T/O _____

CONTRACTOR _____ ADDRESS _____

PREPARED BY _____ PHONE _____ DATE PREPARED _____

GSFC MATERIALS EVALUATOR _____ PHONE _____ DATE RECEIVED _____ DATE EVALUATED _____

ITEM NO.	COMPONENT TYPE, SIZE, MATERIAL[1]	COMPONENT MANUFACTURER & MFR. IDENTIFICATION	PROPOSED LUBRICATION SYSTEM & AMT. OF LUBRICANT	TYPE & NO. OF WEAR CYCLES[2]	SPEED, TEMP., ATM. OF OPERATION[3]	TYPE OF LOADS & AMT.[4]	OTHER DETAILS[5]	GSFC EVALUATION[6]		
								A	NA	SA

GSFC SPACECRAFT MATERIALS PROCESSES LIST

SPACECRAFT _____ SYSTEM/EXPERIMENT _____ GSFC T/O _____

CONTRACTOR _____ ADDRESS _____

PREPARED BY _____ PHONE _____ DATE PREPARED _____

GSFC MATERIALS EVALUATOR _____ PHONE _____ DATE RECEIVED _____ DATE EVALUATED _____

ITEM NO	PROCESS TYPE[1]	CONTRACTOR SPEC. NO.[2]	MIL., ASTM, FED., OR OTHER SPEC. NO.	DESCRIPTION OF MAT'L. PROCESSED[3]	SPACECRAFT/EXP. APPLICATION[4]	GSFC EVALUATION[5]		
						A	NA	SA

See reverse side for notes

GSFC 18-500 1/78

Out Form.

reverse side of this form.

☆U.S.Government Printing Office: 1976-224-956

GSFC MALFUNCTION REPORT

NoF 03187

(1) Project		(2) Spacecraft		(3) Operation		(4) Units HRS 1 ☐ CYS 2 ☐					
(5) System or Experiment		(6) Date & Time of Malfunction	Yr	Mo	Day	Time	(7) Date of Report	Mo	Day	(8) Critical YES 1 ☐ NO 2 ☐	
NAME		IDENTIFICATION NUMBER		SERIAL NUMBER →		MANUFACTURER					
(9) Component											
(10) Assembly											
(11) Sub-Assembly											
(12) Part		Manufacturers Part Number									

(13) Malfunction Occurred During	1 ☐ Qualification Test 2 ☐ Acceptance Test	3 ☐ Integration Test 5 ☐ Launch Operations	7 ☐ Bench Test 8 ☐ Post Launch			
(14) Environment When Failed	1 ☐ Acceleration 2 ☐ Shock	3 ☐ Thermal-Vacuum 4 ☐ Temperature	5 ☐ Humidity 6 ☐ Vibration	7 ☐ Ambient 8 ☐ Acoustic	A ☐ RFI/EMC 0 ☐ Vacuum	
(15) Hardware Level When Failed	1 ☐ Part 2 ☐ Sub-Assembly	3 ☐ Assembly 4 ☐ Component	5 ☐ System 6 ☐ Spacecraft			

(16) REFERENCE
Spacecraft Log Book # _____ Page _____ Test Procedure _____ Para _____

(17) Description of the Malfunction:

(18) Originator: | Phone: | Organization:

Do Not Write Below This Line

INSTRUCTIONS

(1) Originator – Fill in blocks (1) through (18), with all known information, as defined in instructions on the back of this form.

(2) Distribute copies in accordance with project directions.

77

Copy 1

GSFC 4-2 (11/76)

GOVERNMENT-INDUSTRY DATA EXCHANGE PROGRAM

ALERT

Please Type All Information - See Instructions On Reverse

Form Approved
OMB No. 0704-0188

1. NOMENCLATURE *(Part/Material/Hazard/Safety Problems)*	2. ALERT/SAFE-ALERT NO.
	3. DATE *(Year, Month, Day)*
4. MANUFACTURER AND ADDRESS	5. NSN
	6. PROCUREMENT SPECIFICATION / 7. REFERENCE
	8. MANUFACTURER'S PART NUMBER / 9. LOT/DATE CODE OR SERIAL NO.
10. SPECIAL REQUIREMENTS OR ENVIRONMENT *(Requirements placed on, or extreme environment to which item was exposed)*	
11. PROBLEM SITUATION AND CAUSE *(State facts of problem and cause-failure mode and mechanism-project function)*	
12. ACTIONS TAKEN *(State all actions taken to correct the problem situation and to prevent its recurrence)*	
13. DATE MFR NOTIFIED *(Year, Month, Day)*	14. MANUFACTURER RESPONSE ☐ CORRESPONDENCE ATTACHED ☐ DID NOT REPLY
	15. CONTACT POINTS FOR INFORMATION *(Name, Affiliation, Phone)*
16. ALERT COORDINATOR *(Name, Affiliation)*	17. SIGNATURE OF ALERT COORDINATOR

18 NOMENCLATURE

19 ALERT/SAFE-ALERT NO.

DD Form 1938, JUN 86 ***Previous editions are obsolete.***